2.5 — Short Run Profit Maximization

ECON 306 • Microeconomic Analysis • Spring 2021

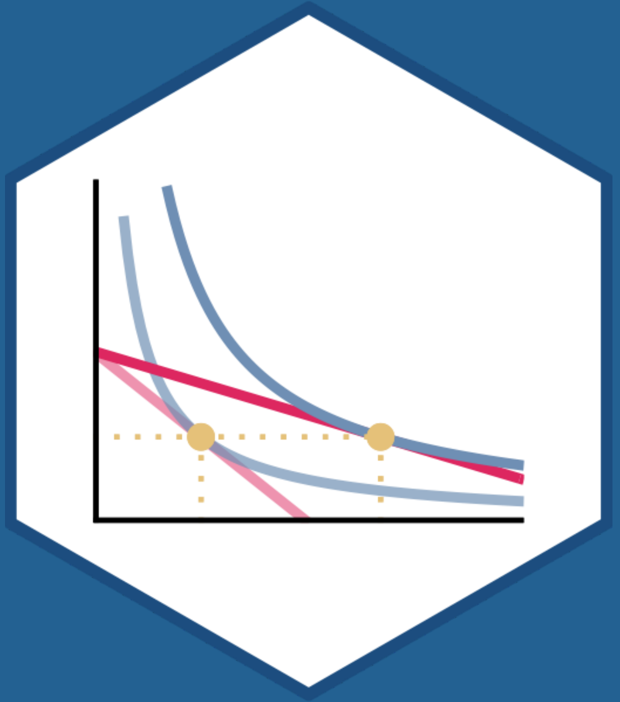
Ryan Safner

Assistant Professor of Economics

safner@hood.edu

ryansafner/microS21

microS21.classes.ryansafner.com



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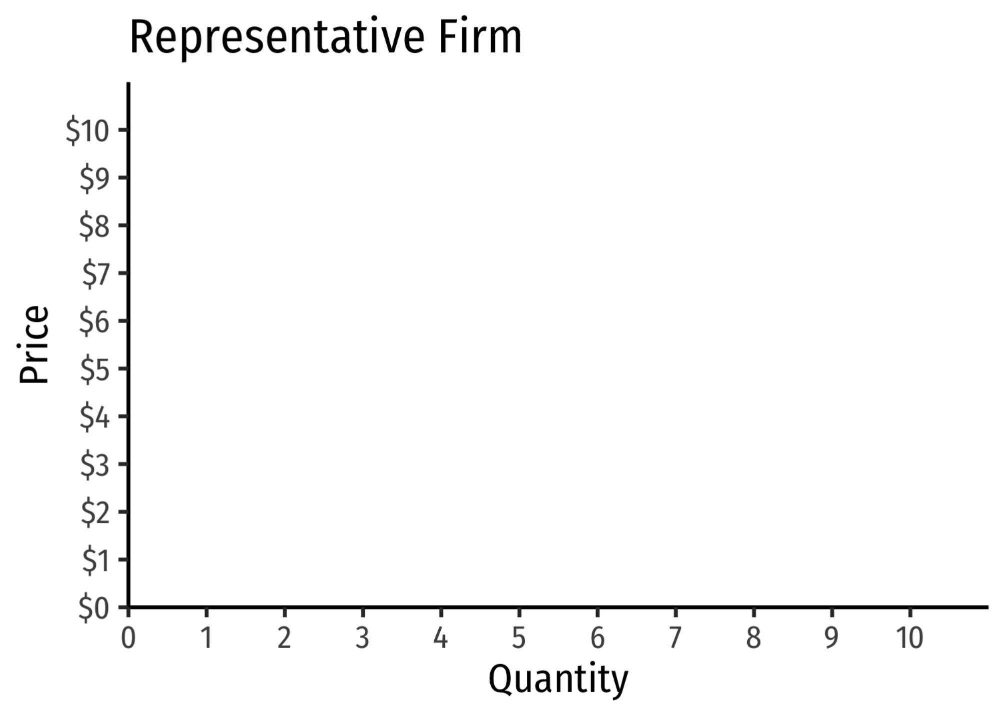
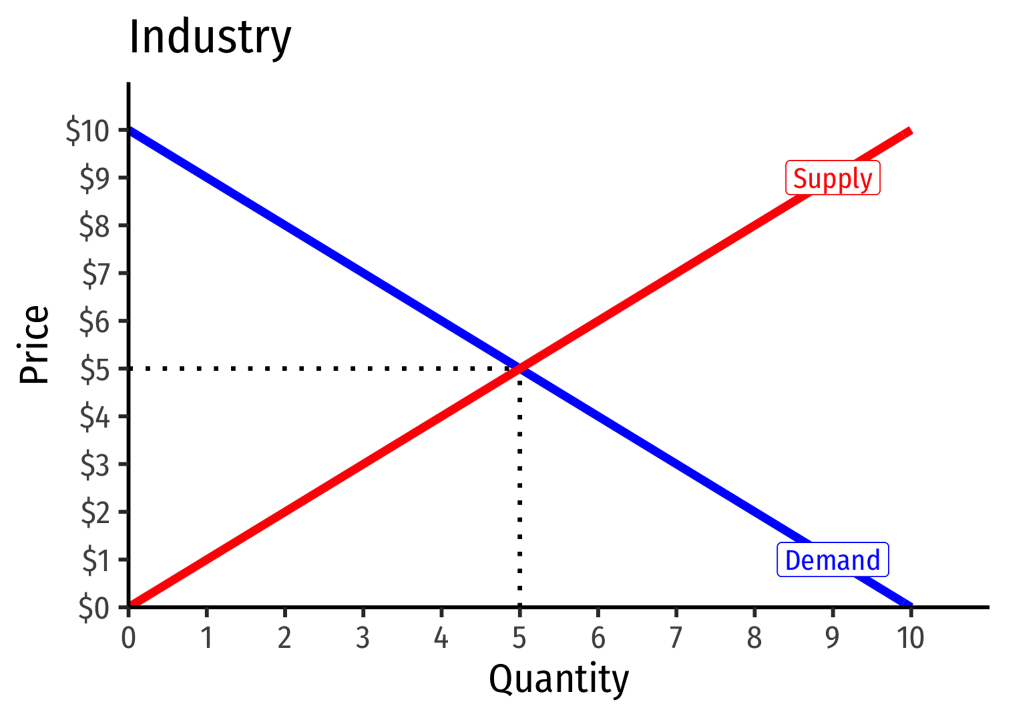
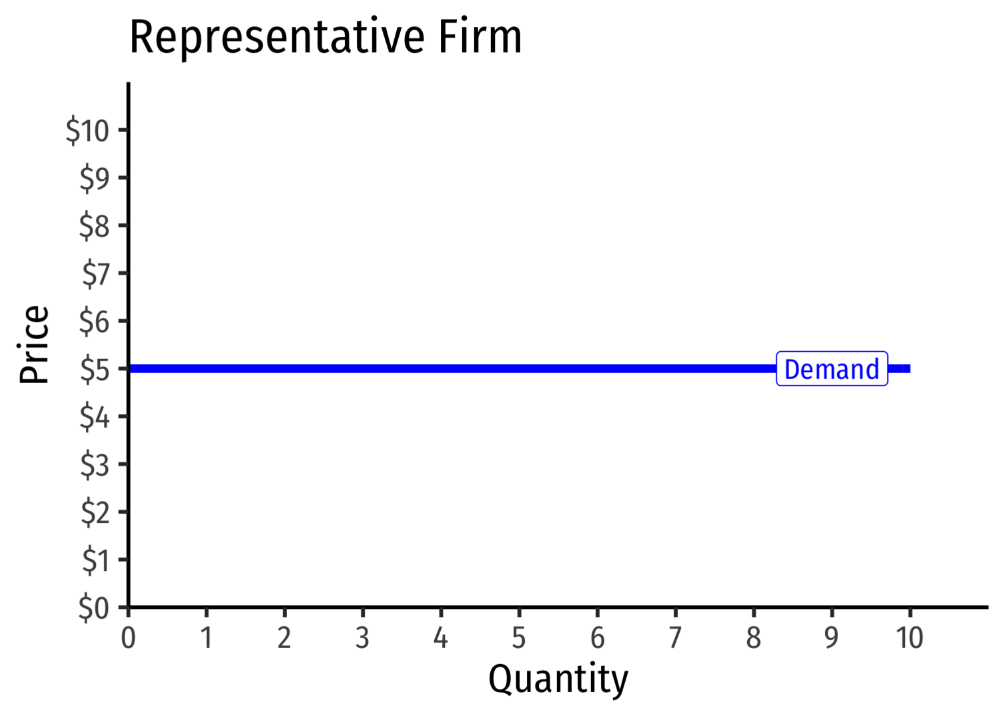
Revenues

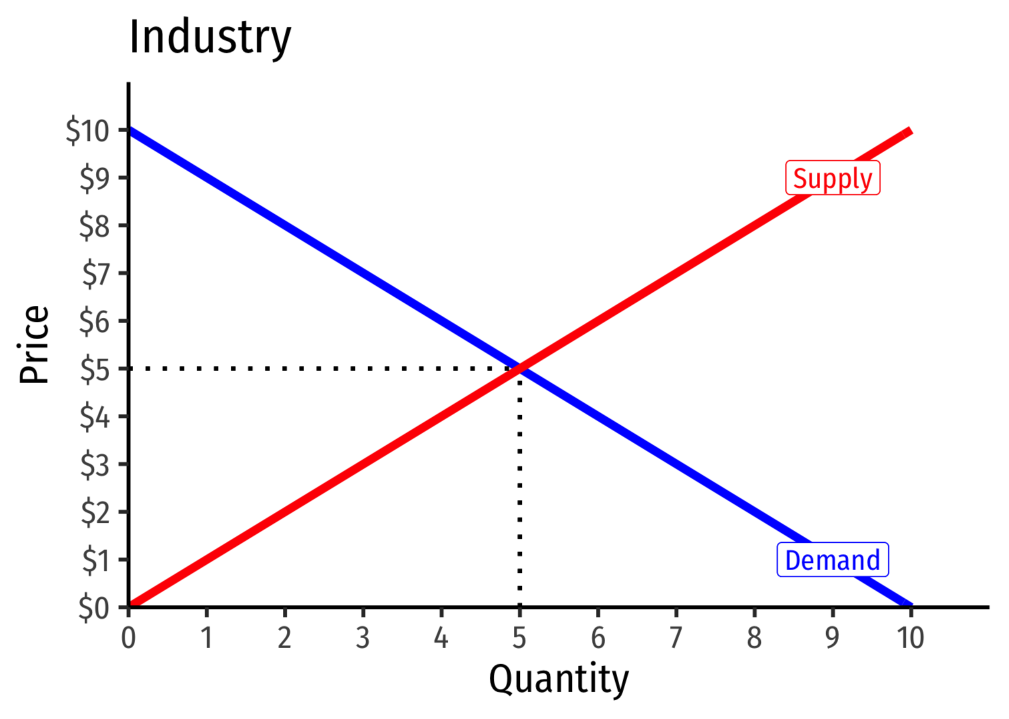
Revenues for Firms in *Competitive* Industries I





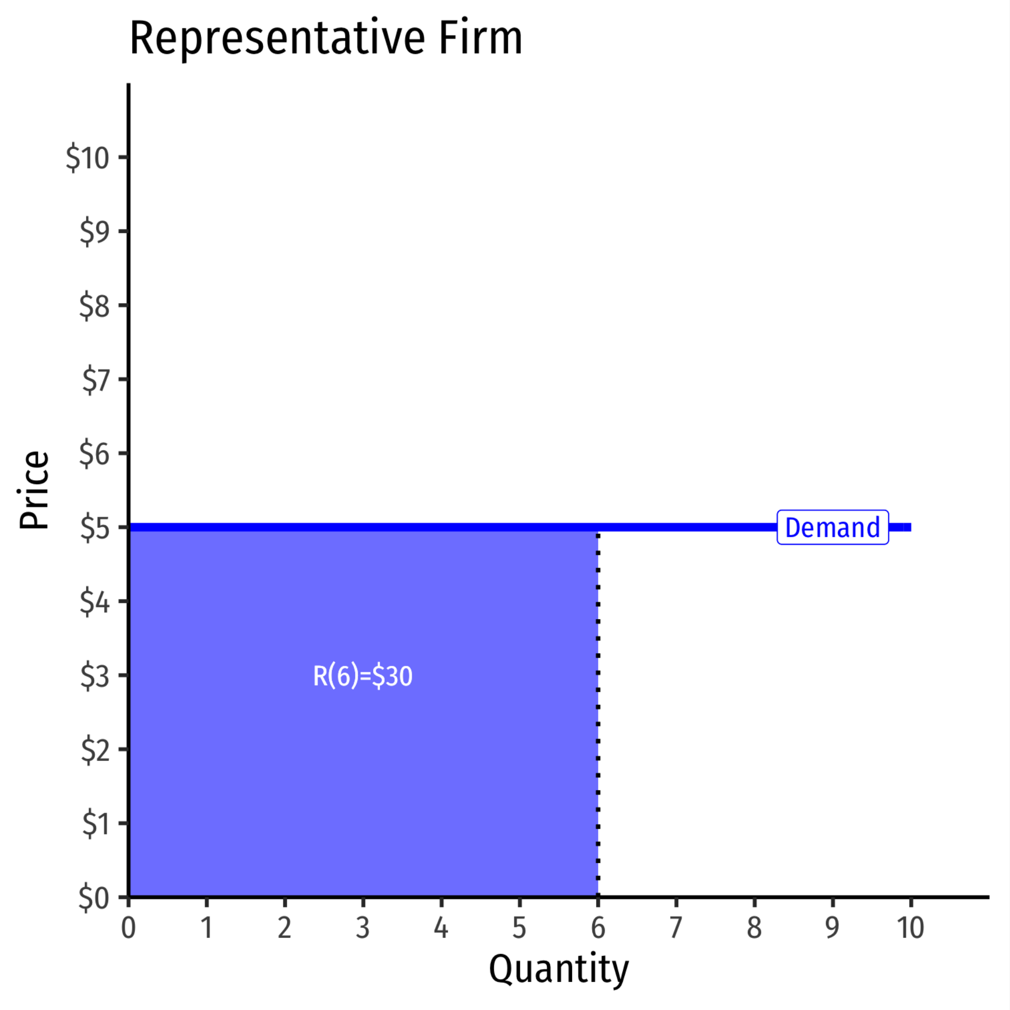
Revenues for Firms in *Competitive* Industries I





- Demand for a firm's product is **perfectly elastic** at the market price
- Where did the supply curve come from? You'll see

Revenues for Firms in *Competitive* Industries II



- **Total Revenue** $R(q) = pq$

Average and Marginal Revenues

- **Average Revenue**: revenue per unit of output

$$AR(q) = \frac{R}{q}$$

  - Is *always* equal to the price! Why?

- **Marginal Revenue**: change in revenues for each additional unit of output sold:

$$MR(q) = \frac{\Delta R(q)}{\Delta q} \approx \frac{R_2 - R_1}{q_2 - q_1}$$

  - Calculus: first derivative of the revenues function
  - For a *competitive* firm, $MR(q) = p$, the price!

Average and Marginal Revenues: Example

Example: A firm sells bushels of wheat in a very competitive market. The current market price is $10/bushel.

For the 1st bushel sold:

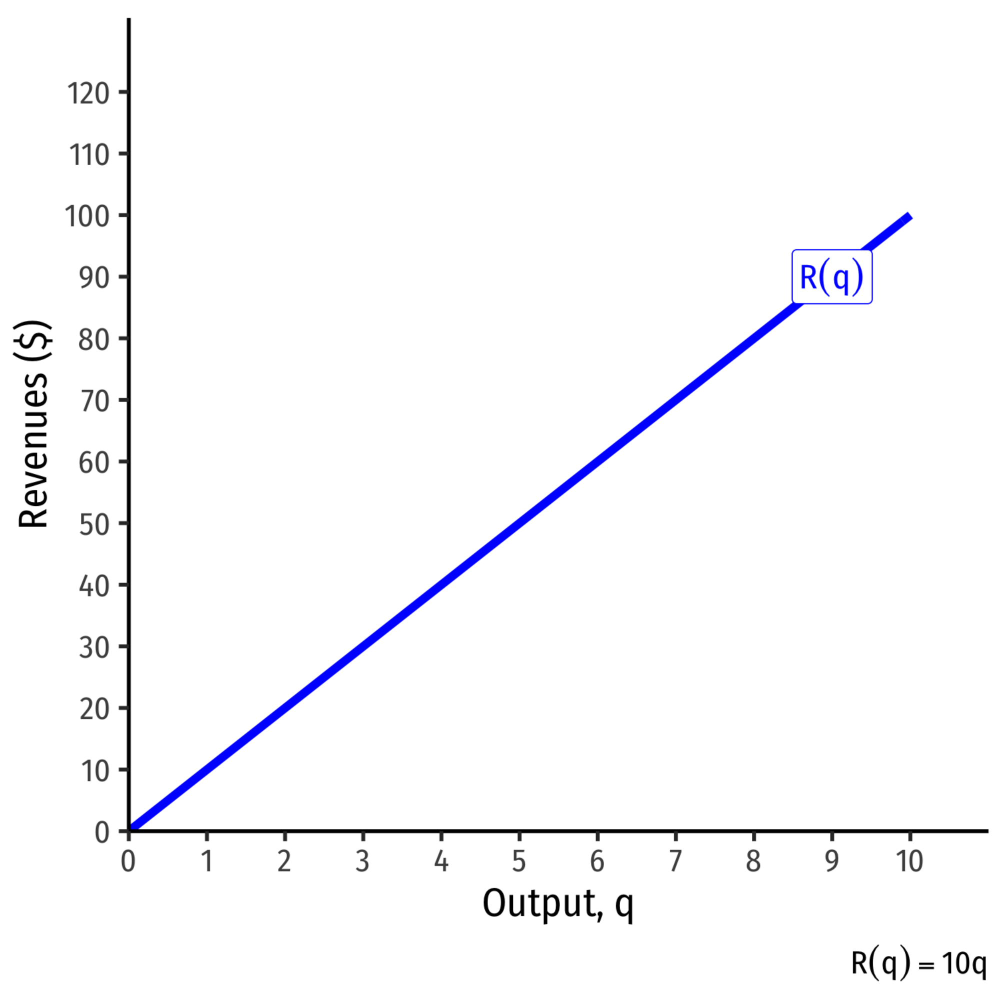
- What is the total revenue?
- What is the average revenue?

For the 2nd bushel sold:

- What is the total revenue?
- What is the average revenue?
- What is the marginal revenue?

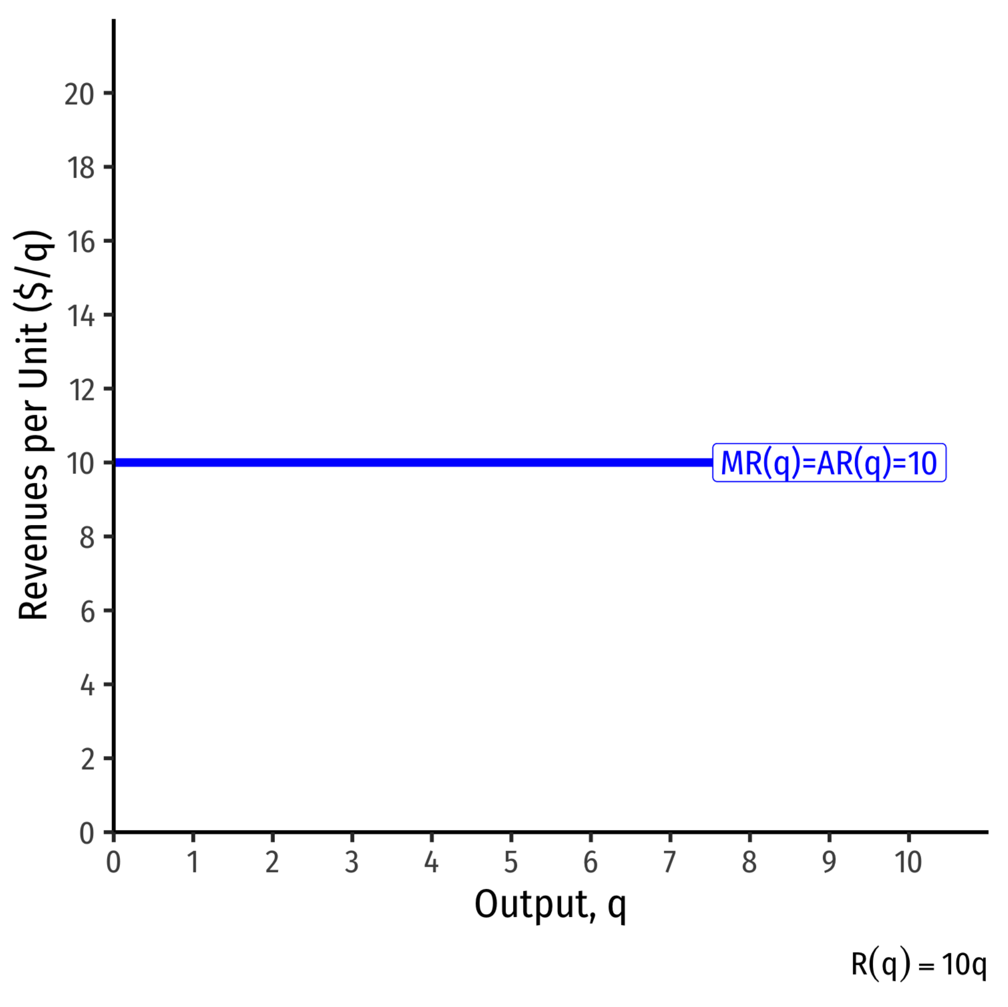
Total Revenue, Example: Visualized

q	$R(q)$
0	0
1	10
2	20
3	30
4	40
5	50
6	60
7	70
8	80
9	90



Average and Marginal Revenue, Example: Visualized

q	$R(q)$	$AR(q)$	$MR(q)$
0	0	–	–
1	10	10	10
2	20	10	10
3	30	10	10
4	40	10	10
5	50	10	10
6	60	10	10
7	70	10	10
8	80	10	10
9	90	10	10



Profits

Recall: The Firm's Two Problems

1st Stage: firm's profit maximization problem:

1. **Choose:** < output >
2. **In order to maximize:** < profits >

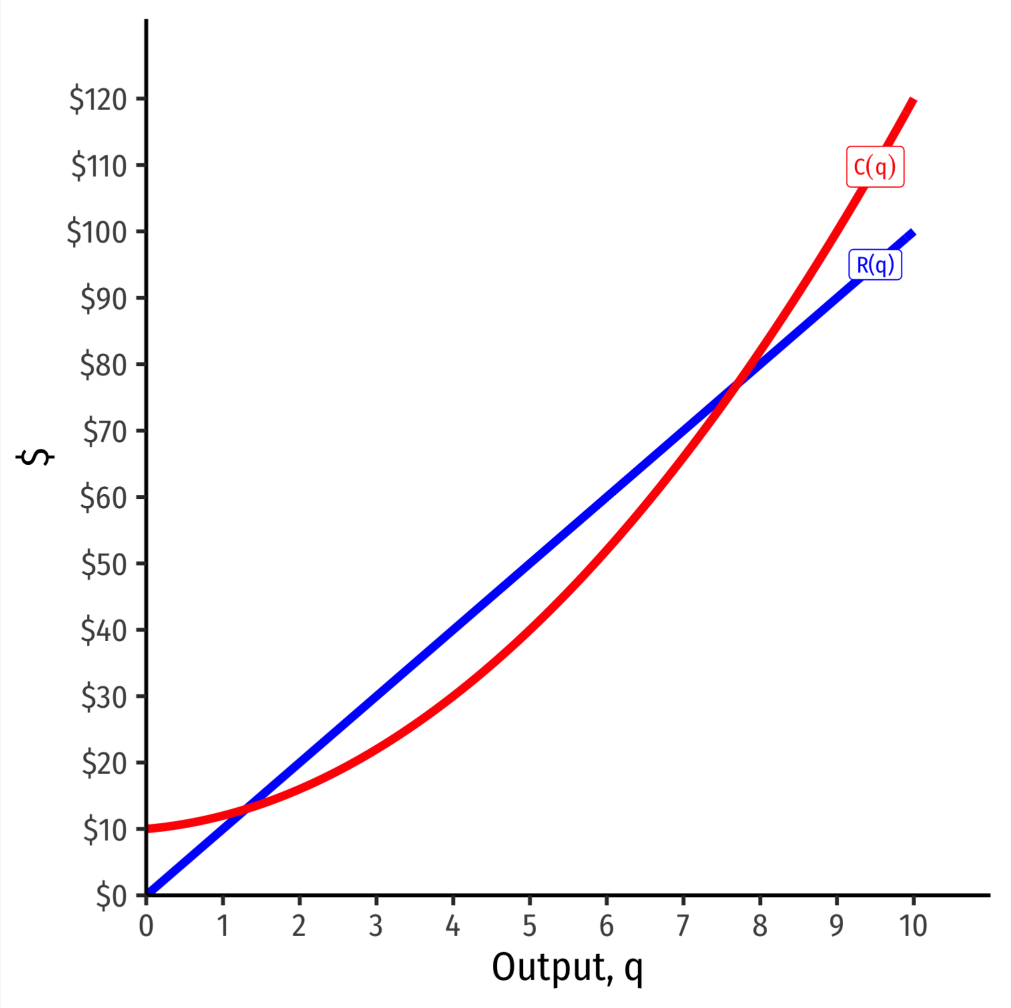
2nd Stage: firm's cost minimization problem:

1. **Choose:** < inputs >
2. **In order to *minimize*:** < cost >
3. **Subject to:** < producing the optimal output >

- Minimizing costs $\iff$ maximizing profits

Visualizing Total Profit As $R(q) - C(q)$

- $\pi(q) = R(q) - C(q)$



Visualizing Total Profit As $R(q) - C(q)$

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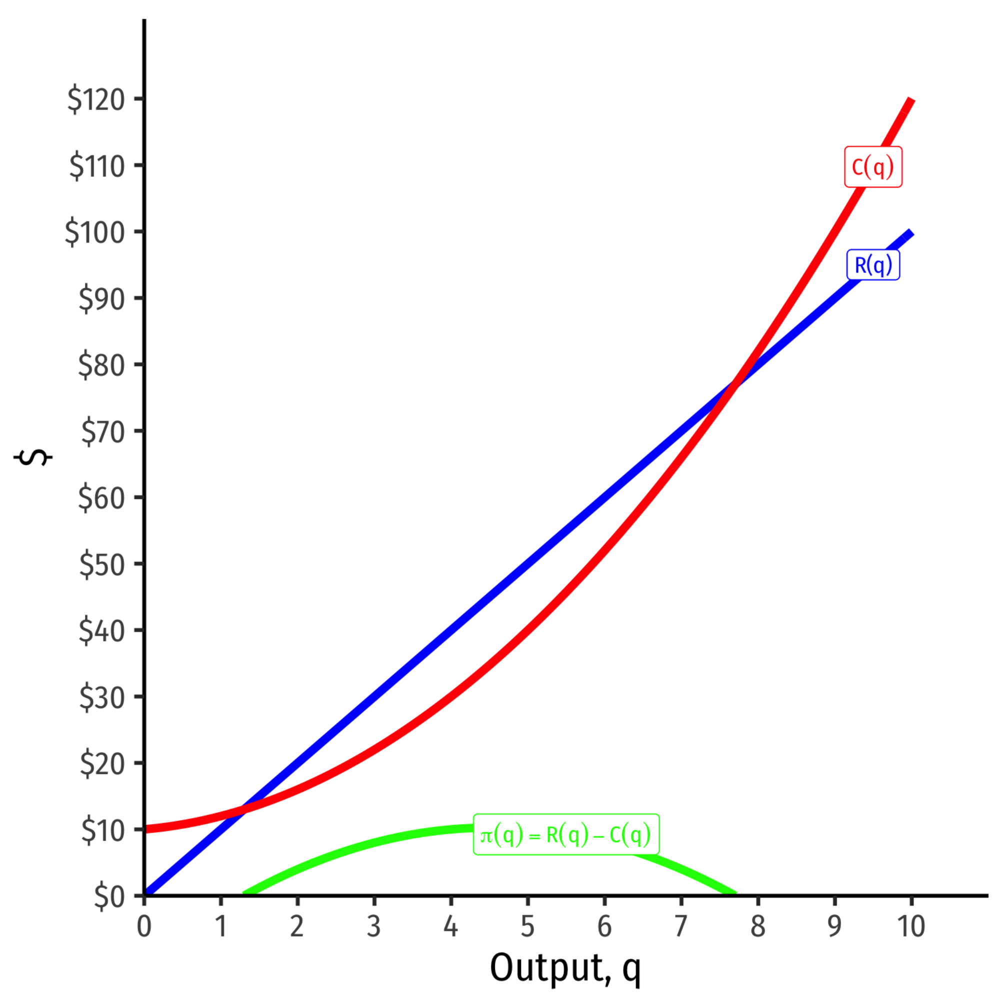
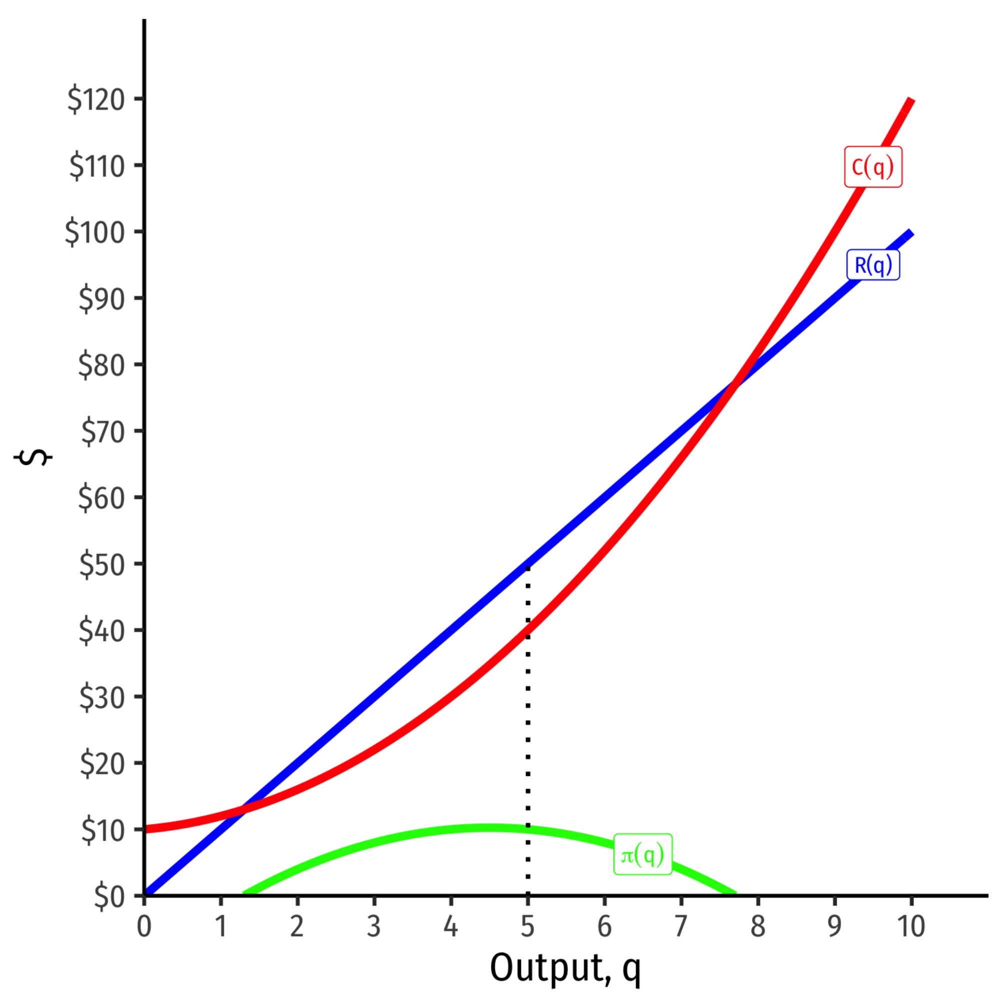


Visualizing Total Profit As $R(q) - C(q)$

- $\pi(q) = R(q) - C(q)$

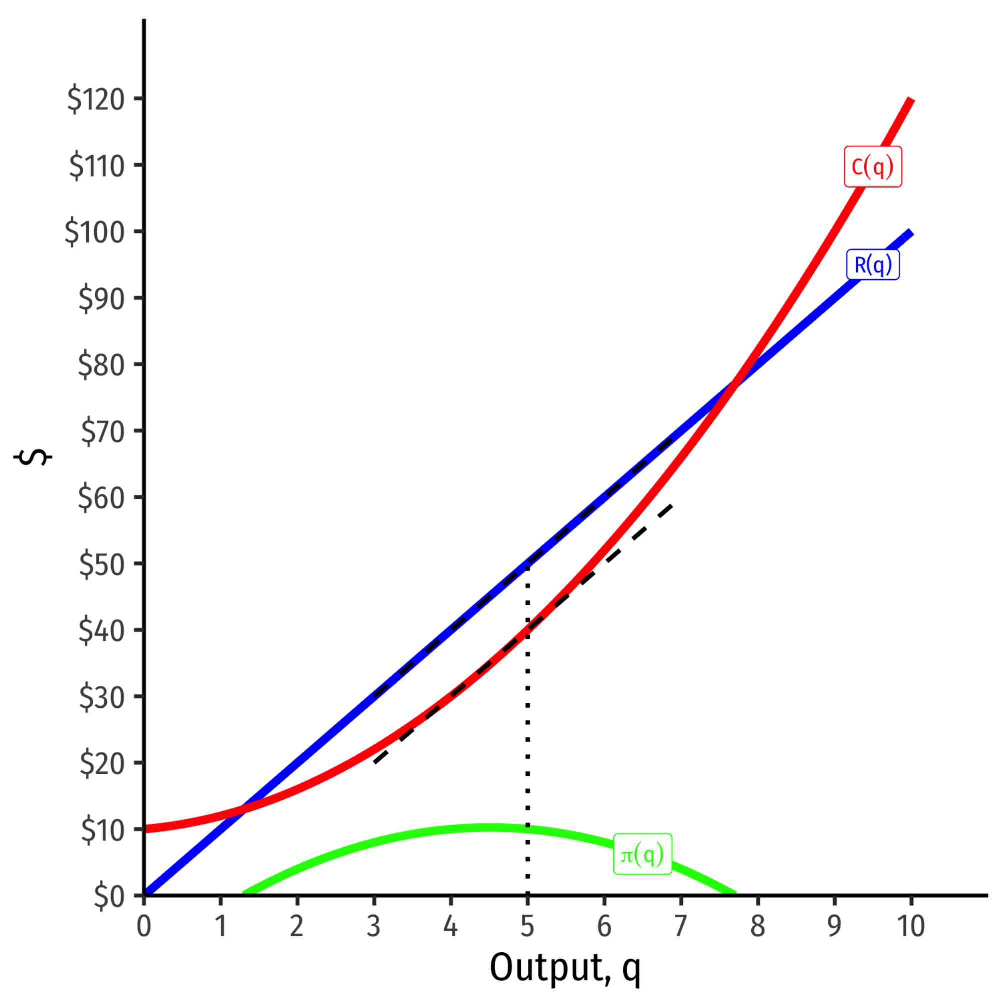
- Graph: find q^* to max $\pi \implies q^*$ where max distance between $R(q)$ and $C(q)$



Visualizing Total Profit As $R(q) - C(q)$

- $\pi(q) = R(q) - C(q)$
- Graph: find q^* to max $\pi \implies q^*$ where max distance between $R(q)$ and $C(q)$
- Slopes must be equal:

$$MR(q) = MC(q)$$

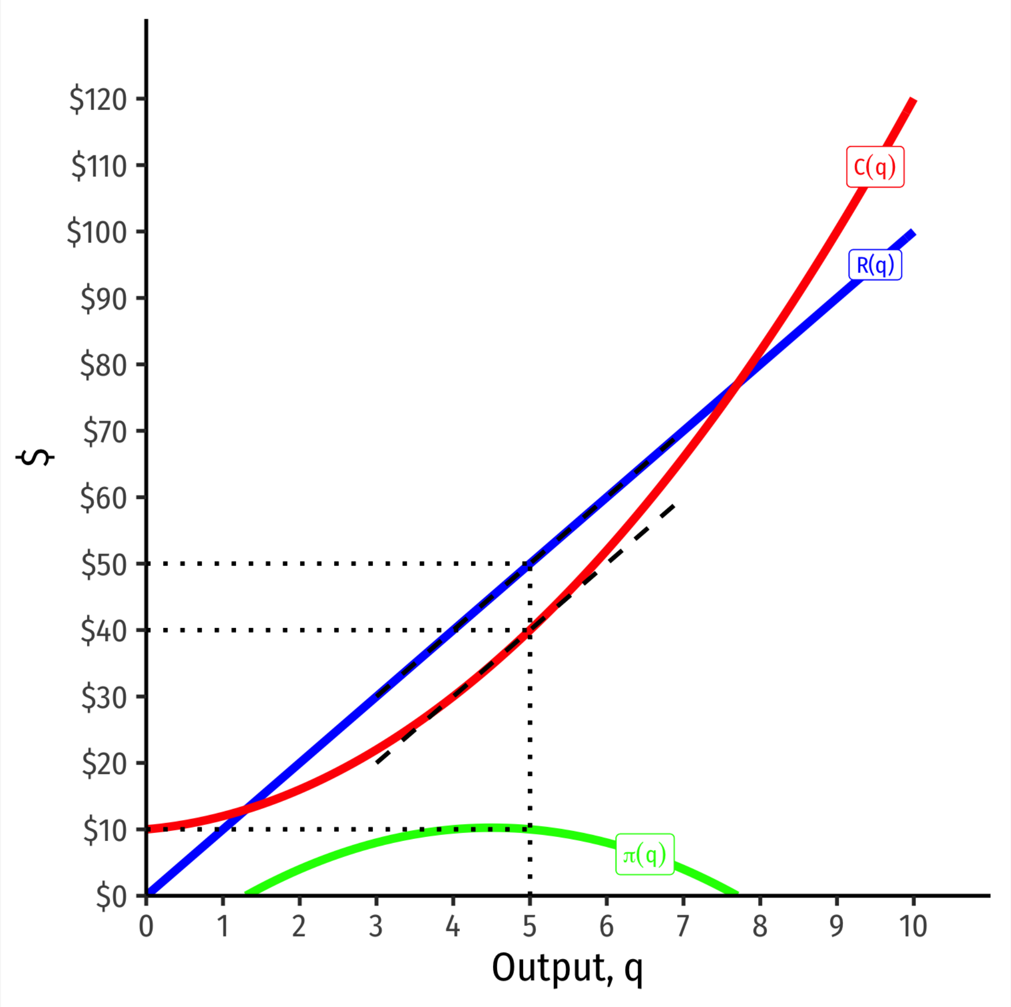


Visualizing Total Profit As $R(q) - C(q)$

- $\pi(q) = R(q) - C(q)$
- Graph: find q^* to max $\pi \implies q^*$ where max distance between $R(q)$ and $C(q)$
- Slopes must be equal:

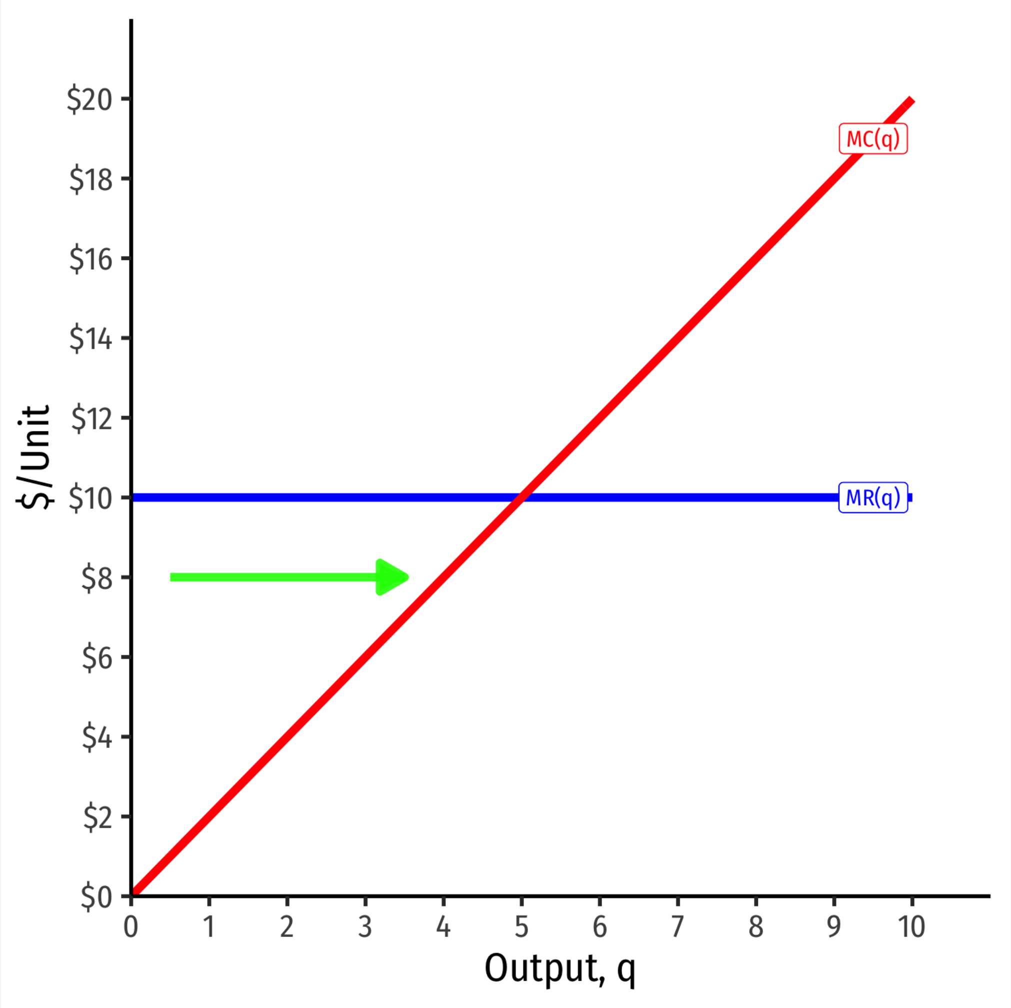
$$MR(q) = MC(q)$$

- At $q^* = 5$:
  - $R(q) = 50$
  - $C(q) = 40$
  - $\pi(q) = 10$



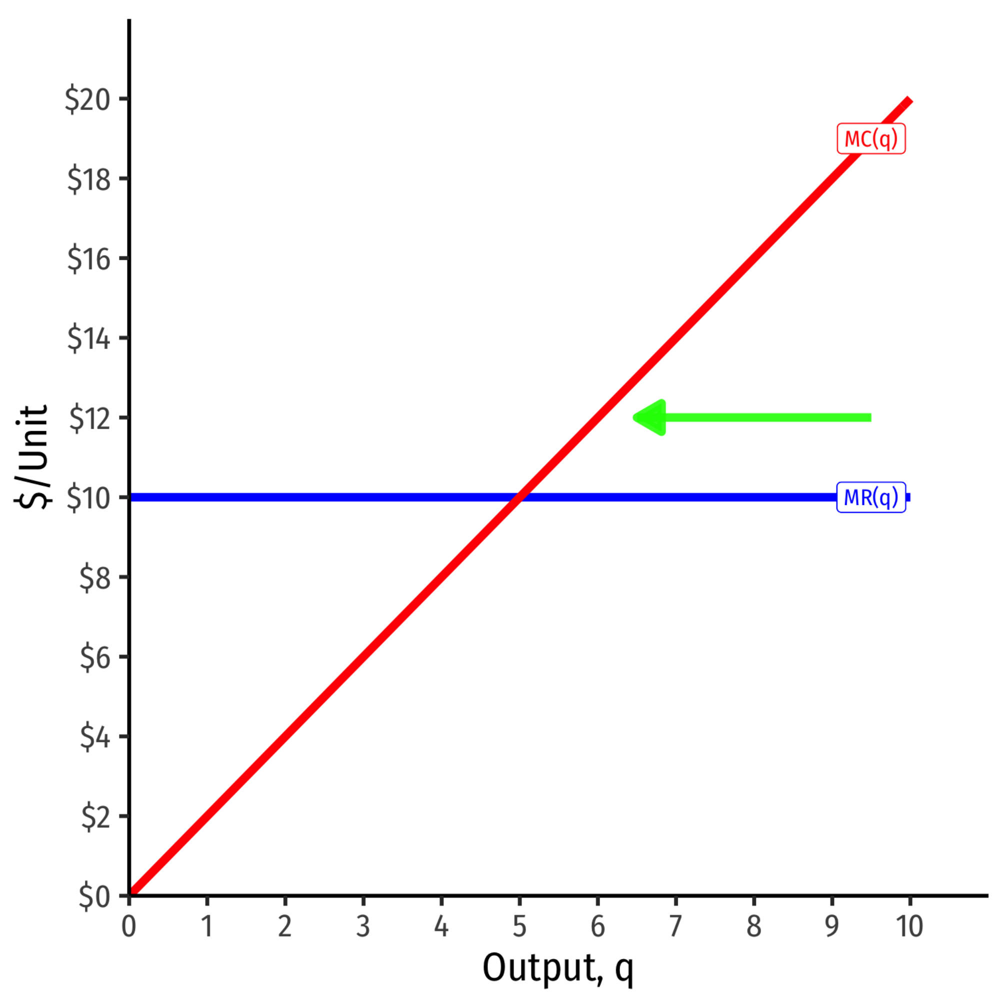
Visualizing Profit Per Unit As $MR(q)$ and $MC(q)$

- At low output $q < q^*$, can increase π by producing *more*: $MR(q) > MC(q)$



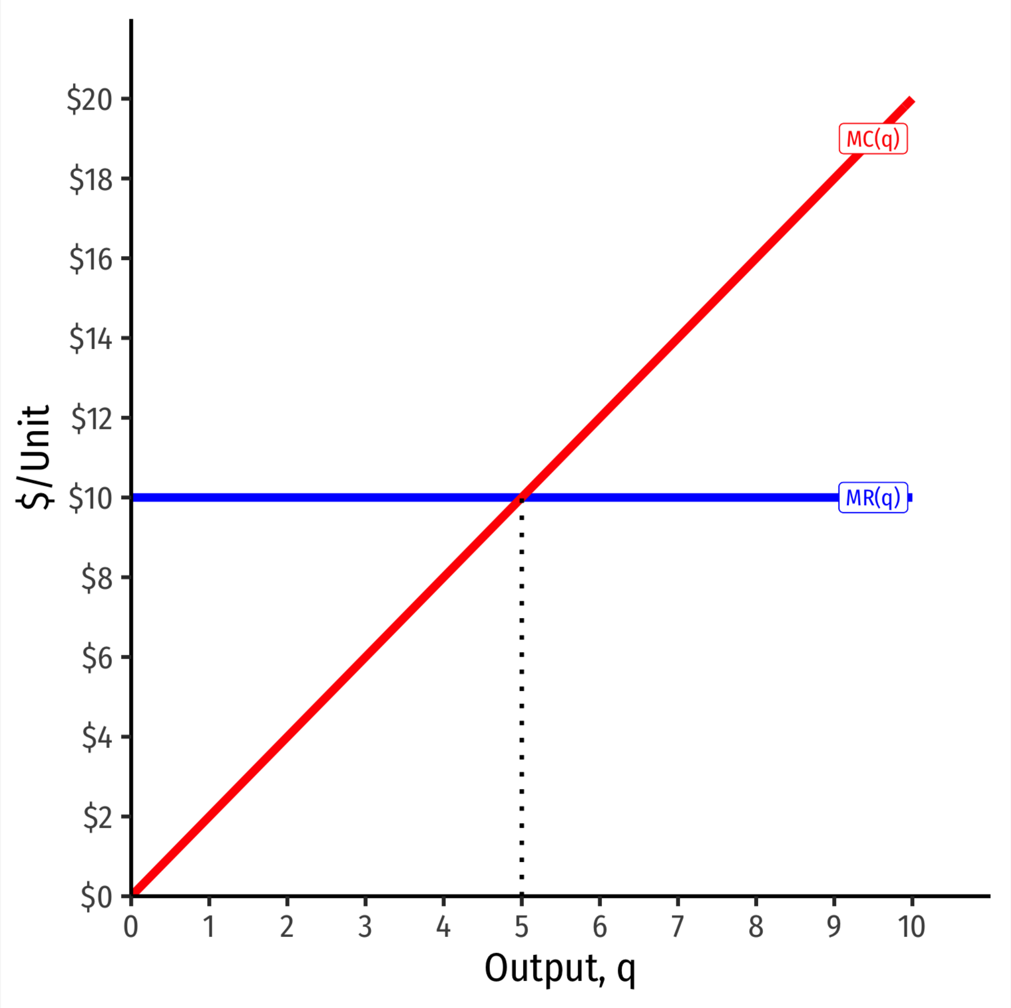
Visualizing Profit Per Unit As $MR(q)$ and $MC(q)$

- At high output $q > q^*$, can increase π by producing *less*: $MR(q) < MC(q)$



Visualizing Profit Per Unit As $MR(q)$ and $MC(q)$

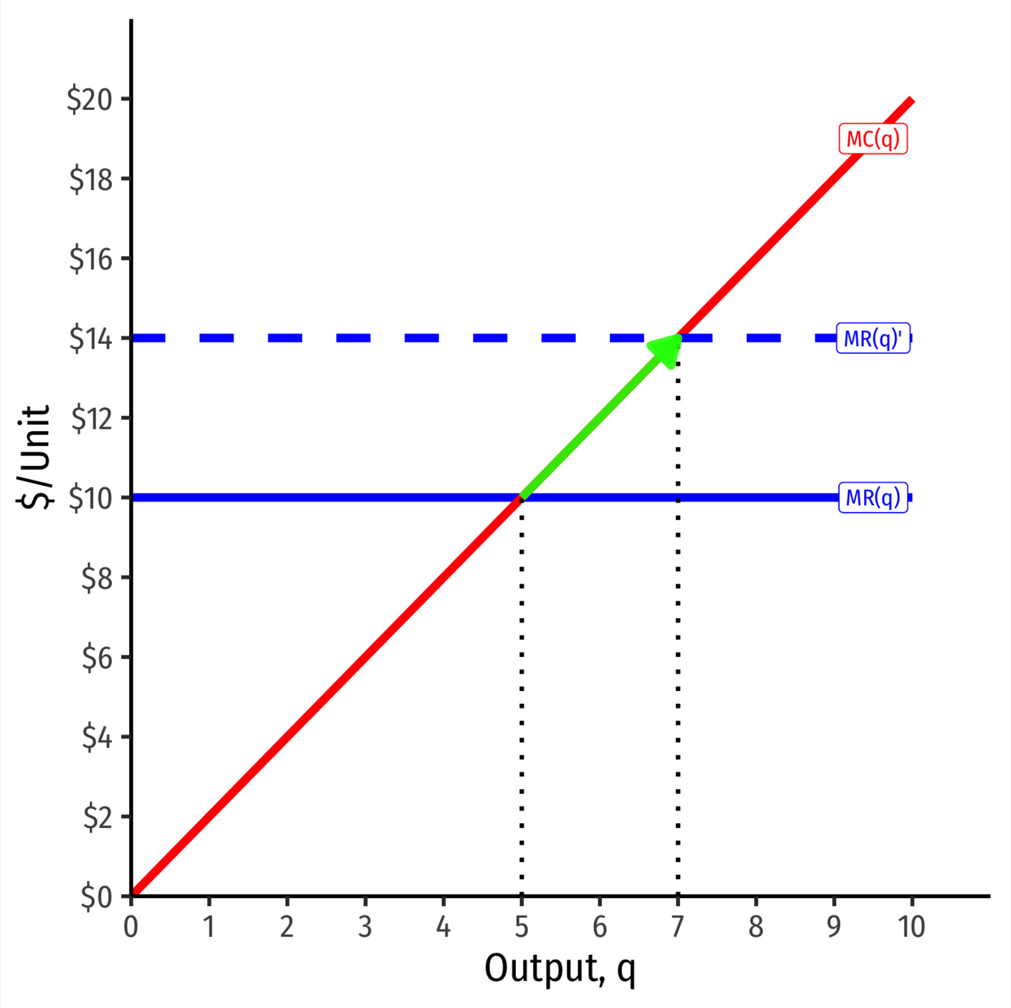
- π is *maximized* where
  $MR(q) = MC(q)$



Comparative Statics

If Market Price Changes I

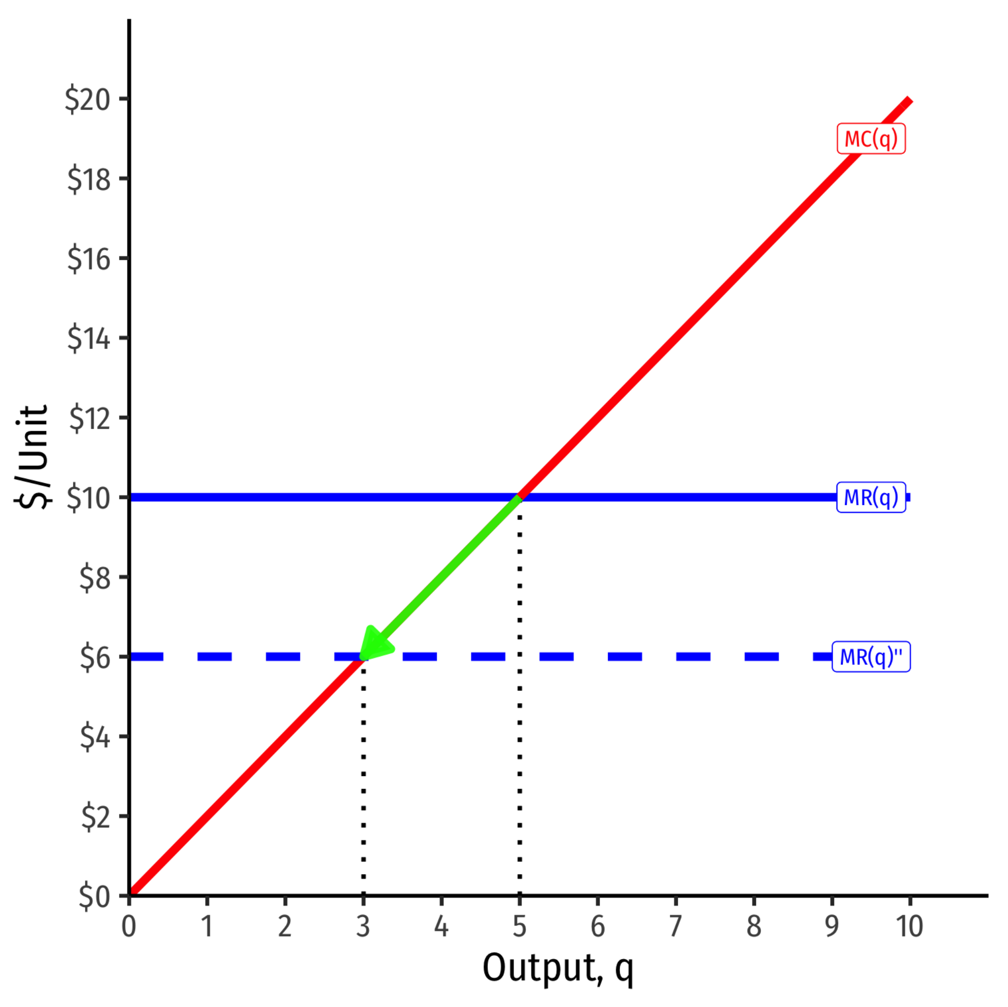
- Suppose the market price *increases*
- Firm (always setting $MR = MC$) will respond by *producing more*



If Market Price Changes II

- Suppose the market price *decreases*

- Firm (always setting $MR = MC$) will respond by *producing more*



If Market Price Changes II

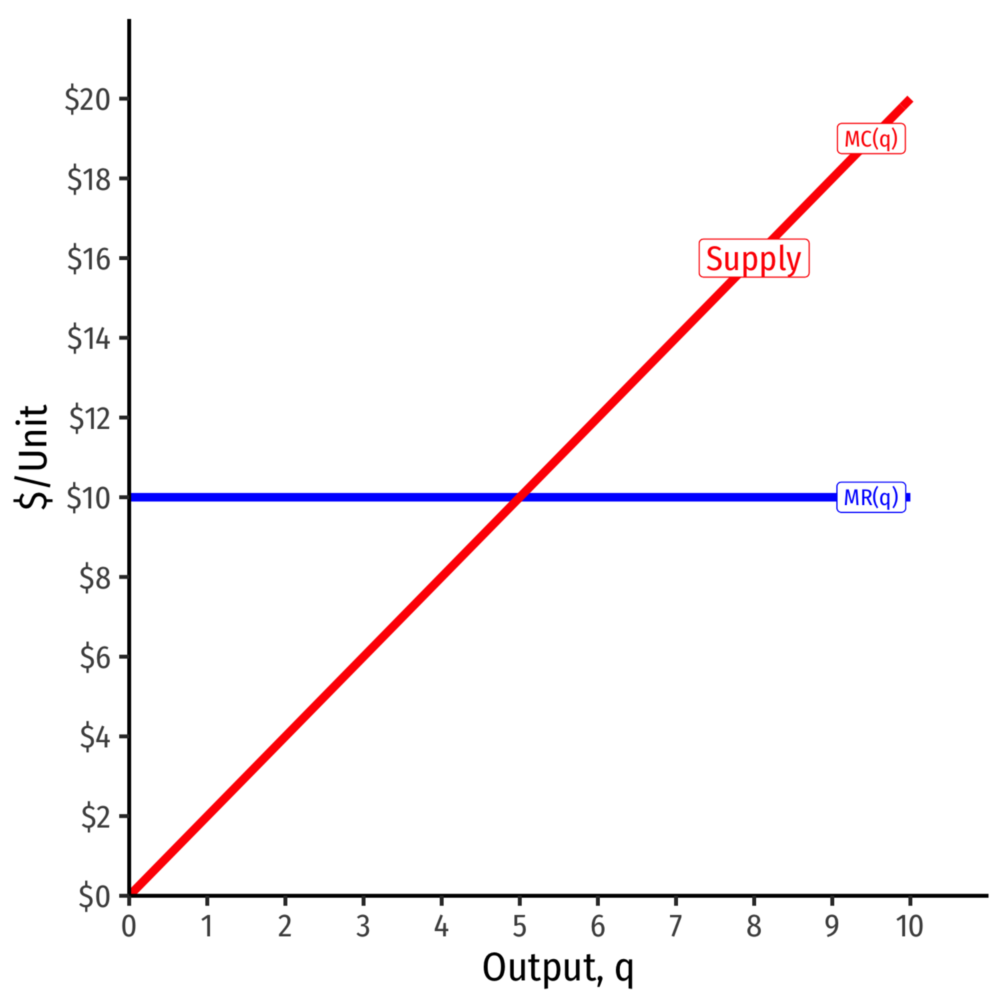
- **The firm's marginal cost curve is its (inverse) supply curve**†

$$Supply = MC(q)$$

  - How it will supply the optimal amount of output in response to the market price

- There is an exception to this! We will see shortly!

† Mostly...there is an exception we will see shortly!

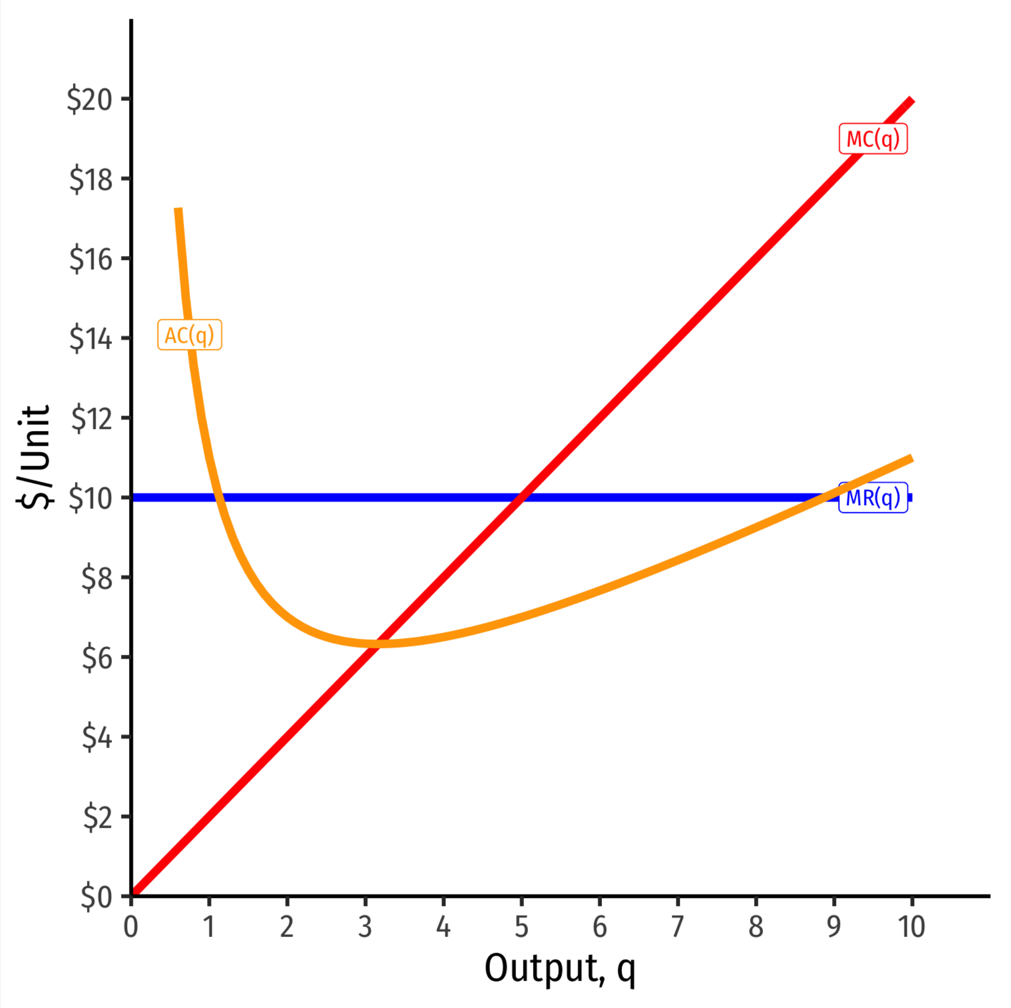


Calculating Profit

Calculating Average Profit as $AR(q) - AC(q)$

- Profit is

$$\pi(q) = R(q) - C(q)$$



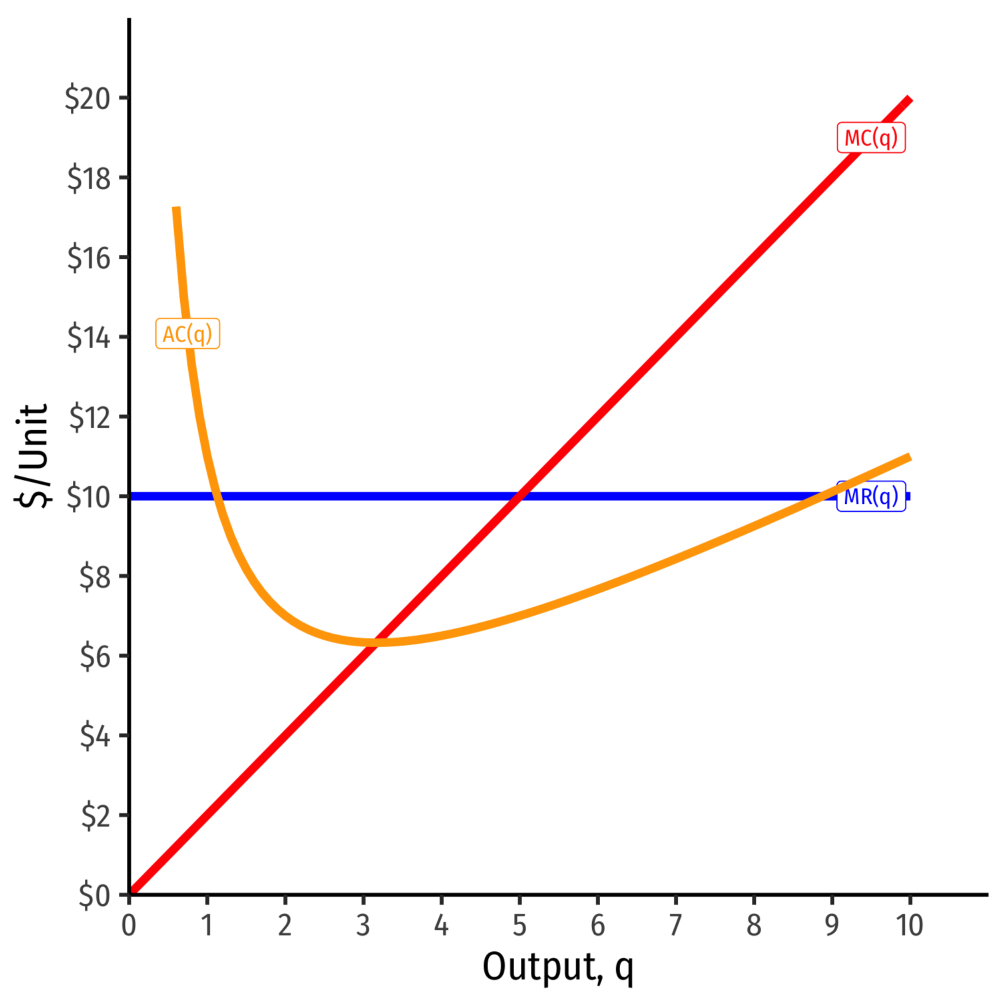
Calculating Average Profit as $AR(q) - AC(q)$

- Profit is

$$\pi(q) = R(q) - C(q)$$

- Profit per unit can be calculated as:

$$\begin{aligned}\frac{\pi(q)}{q} &= AR(q) - AC(q)\\ &= p - AC(q)\end{aligned}$$



Calculating Average Profit as $AR(q) - AC(q)$

- Profit is

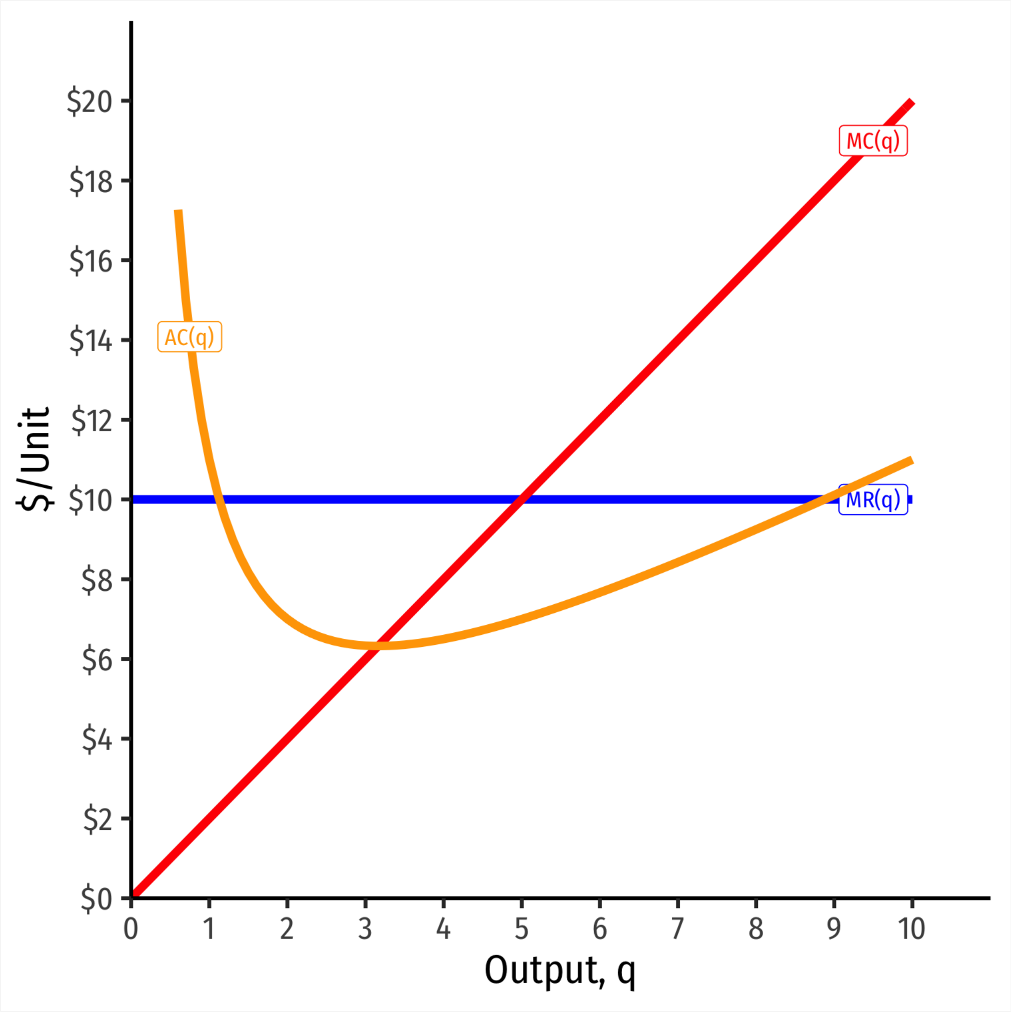
$$\pi(q) = R(q) - C(q)$$

- Profit per unit can be calculated as:

$$\frac{\pi(q)}{q} = AR(q) - AC(q)$$
$$= p - AC(q)$$

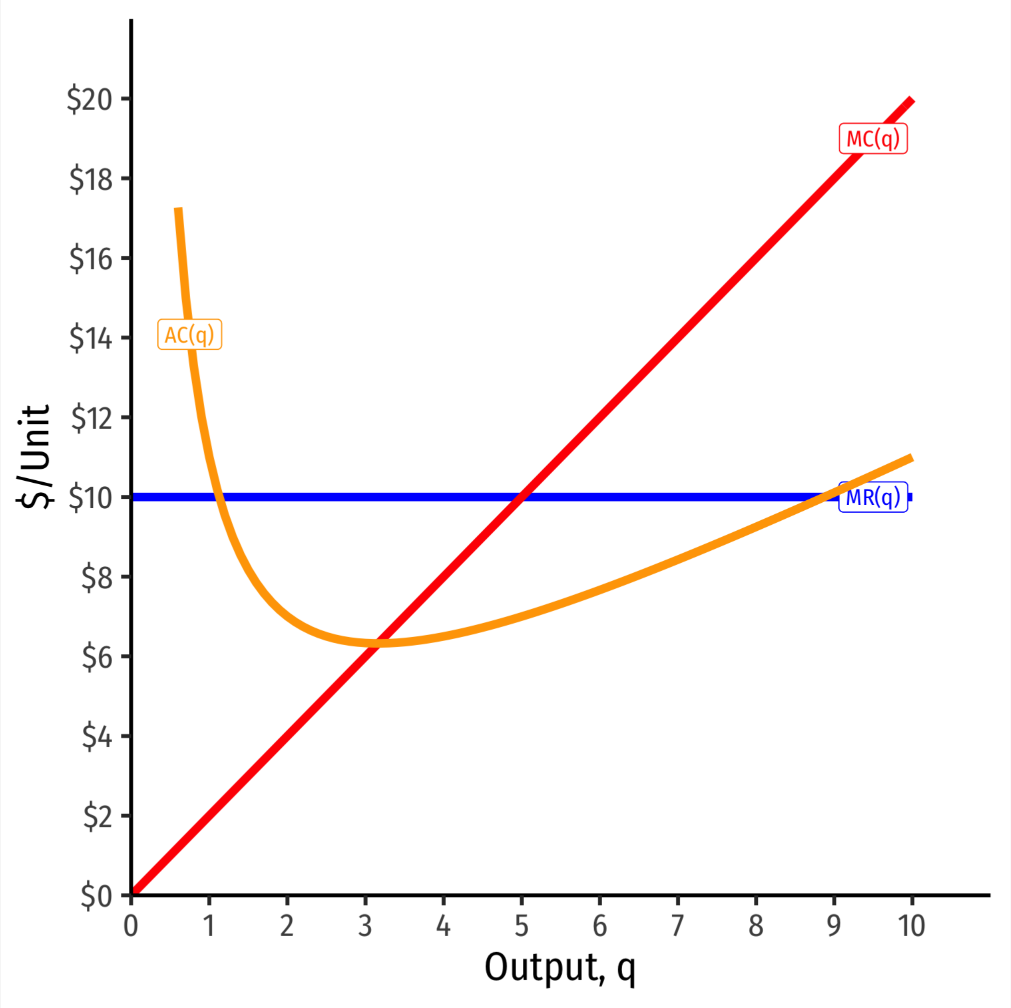
- Multiply by q to get total profit:

$$\pi(q) = q\,[p - AC(q)]$$



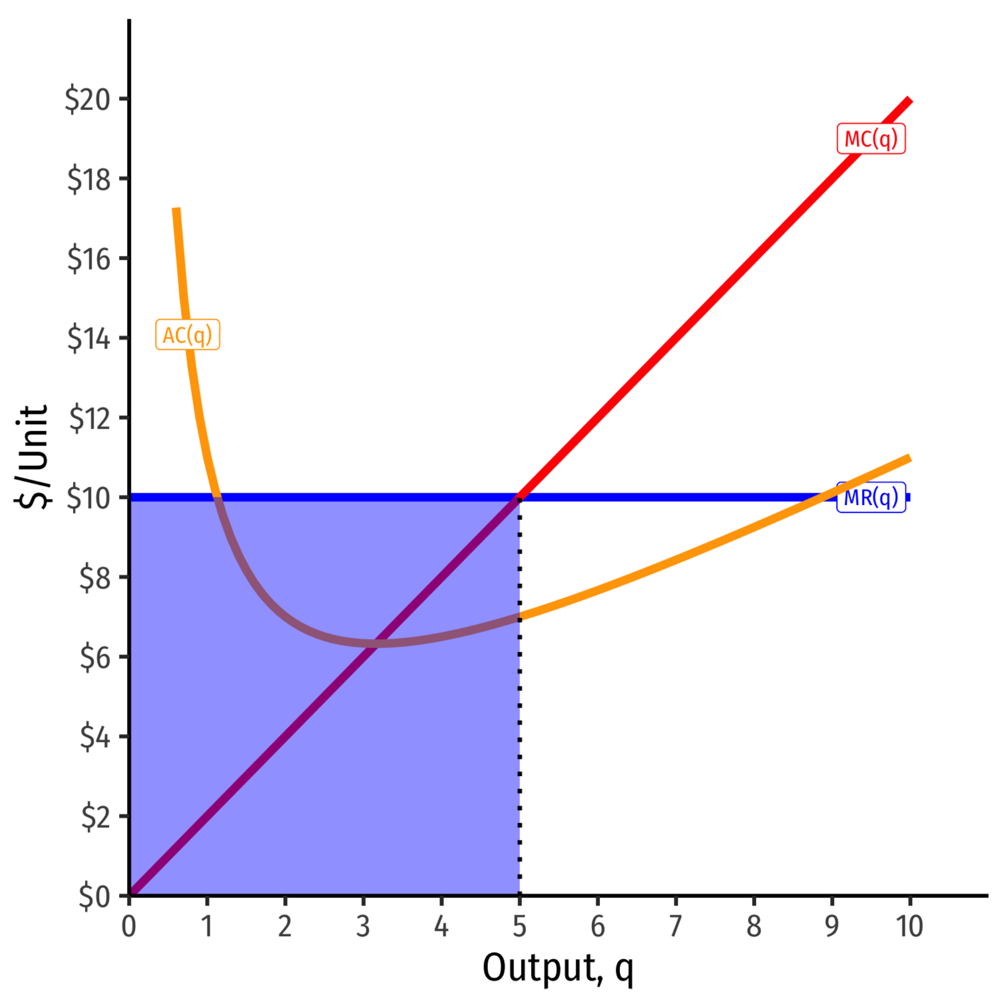
Calculating Average Profit as $AR(q) - AC(q)$

- At market price of p* = $10
- At q* = 5 (per unit):
- At q* = 5 (totals):



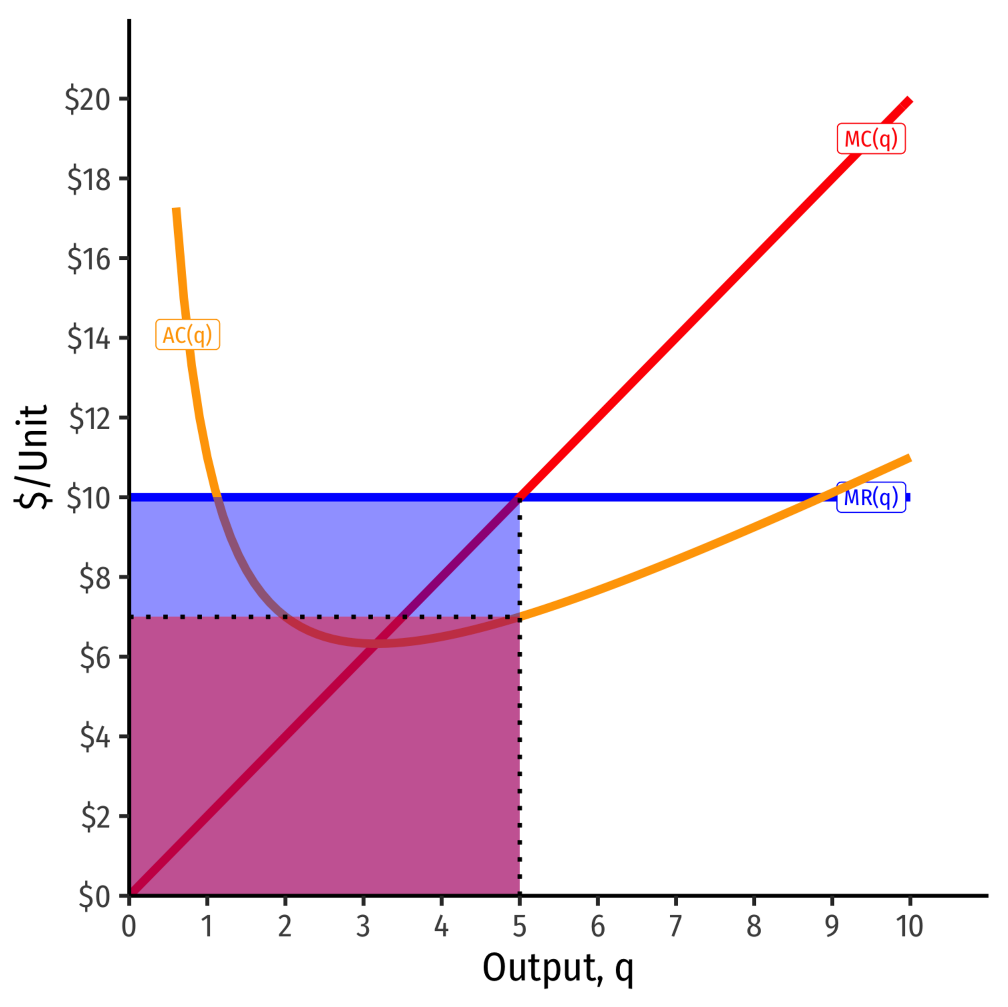
Calculating Average Profit as $AR(q) - AC(q)$

- At market price of p* = $10
- At q* = 5 (per unit):
  - AR(5) = $10/unit
- At q* = 5 (totals):
  - R(5) = $50



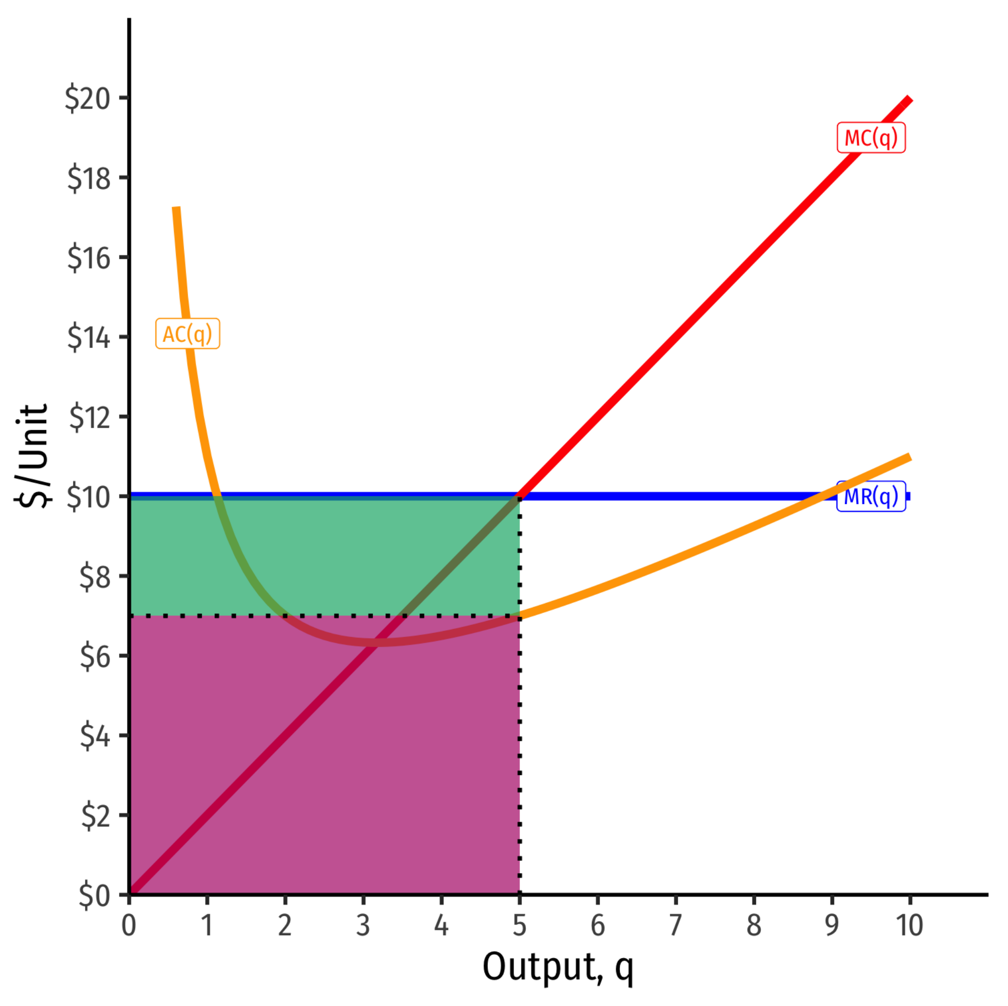
Calculating Average Profit as $AR(q) - AC(q)$

- At market price of $p^* = \$10$
- At $q^* = 5$ (per unit):
  - $AR(5) = \$10/\text{unit}$
  - $AC(5) = \$7/\text{unit}$
- At $q^* = 5$ (totals):
  - $R(5) = \$50$
  - $C(5) = \$35$



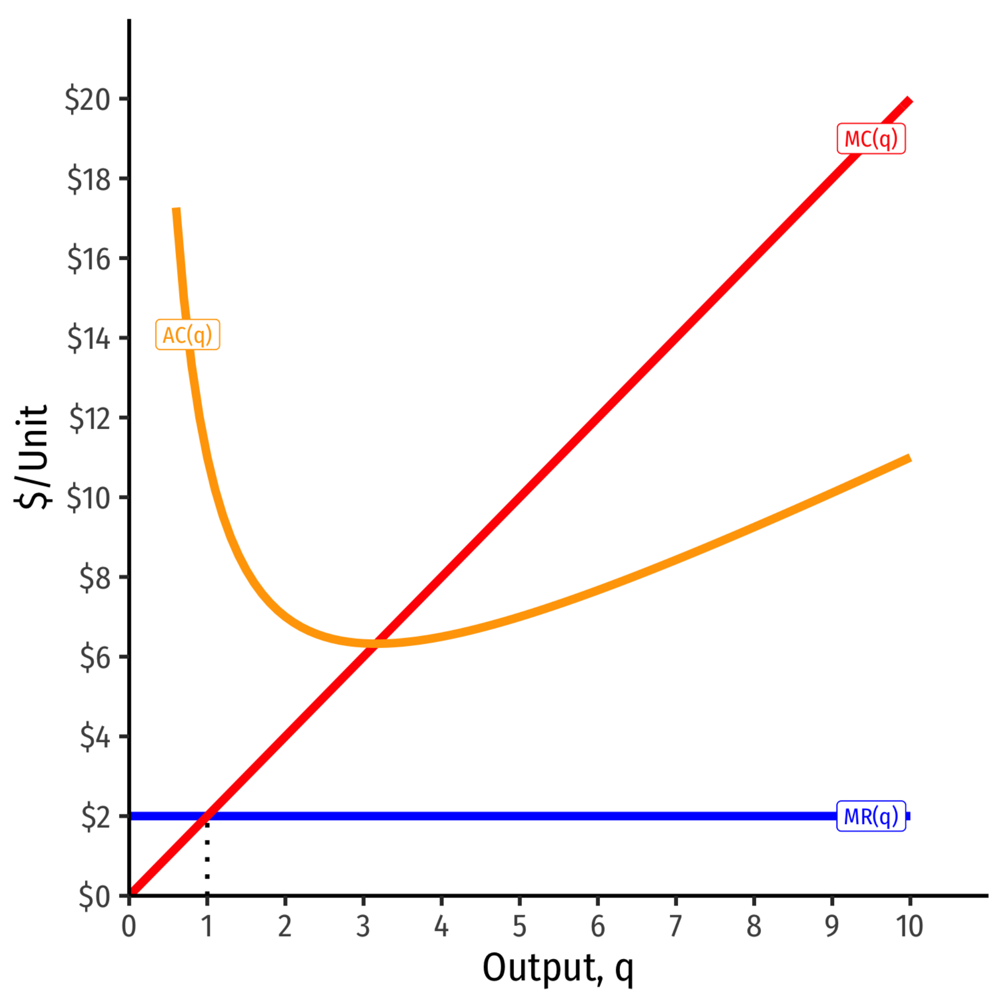
Calculating Average Profit as $AR(q) - AC(q)$

- At market price of p* = $10
- At q* = 5 (per unit):
  - AR(5) = $10/unit
  - AC(5) = $7/unit
  - $A\pi(5)$ = $3/unit
- At q* = 5 (totals):
  - R(5) = $50
  - C(5) = $35
  - π = $15



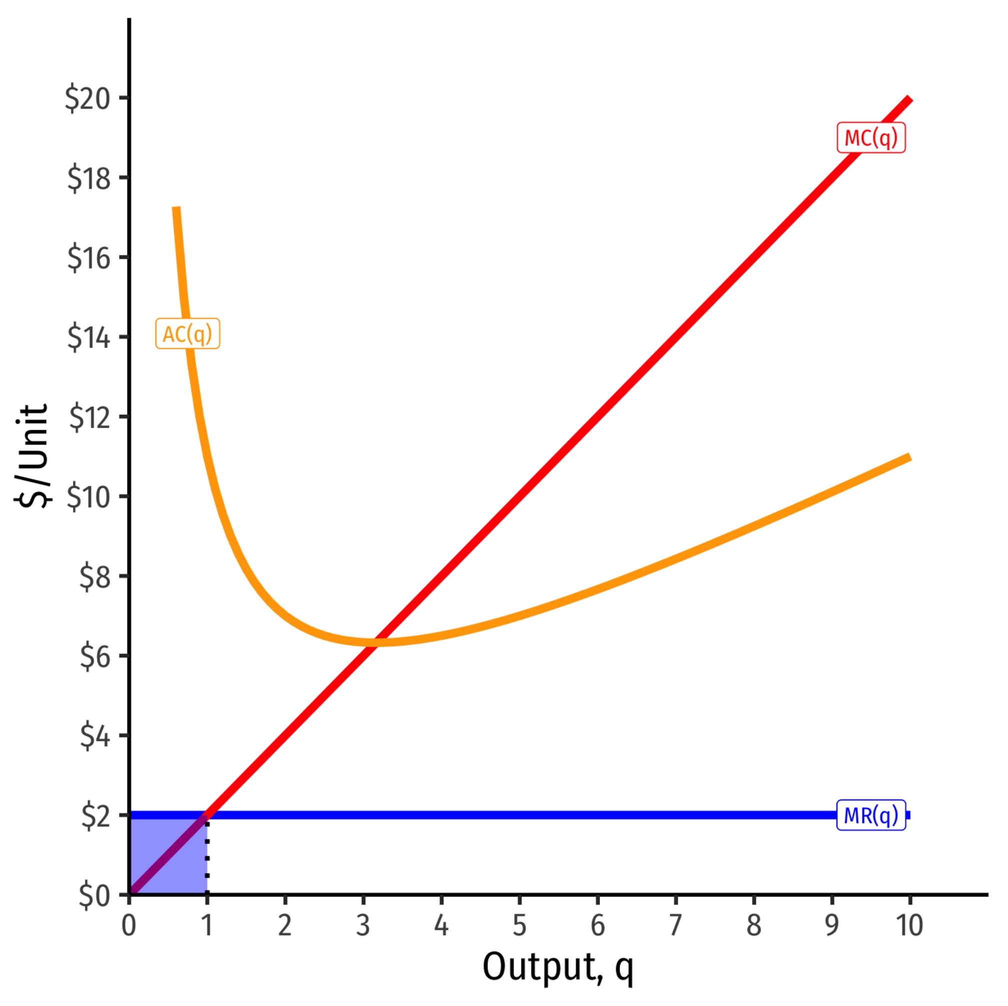
Calculating Average Profit as $AR(q) - AC(q)$

- At market price of $p^* = \$2$
- At $q^* = 1$ (per unit):
- At $q^* = 1$ (totals):



Calculating Average Profit as $AR(q) - AC(q)$

- At market price of p* = $2
- At q* = 1 (per unit):
  - AR(1) = $2/unit
- At q* = 1 (totals):
  - R(1) = $2



Calculating Average Profit as $AR(q) - AC(q)$

- At market price of p* = $2
- At q* = 1 (per unit):
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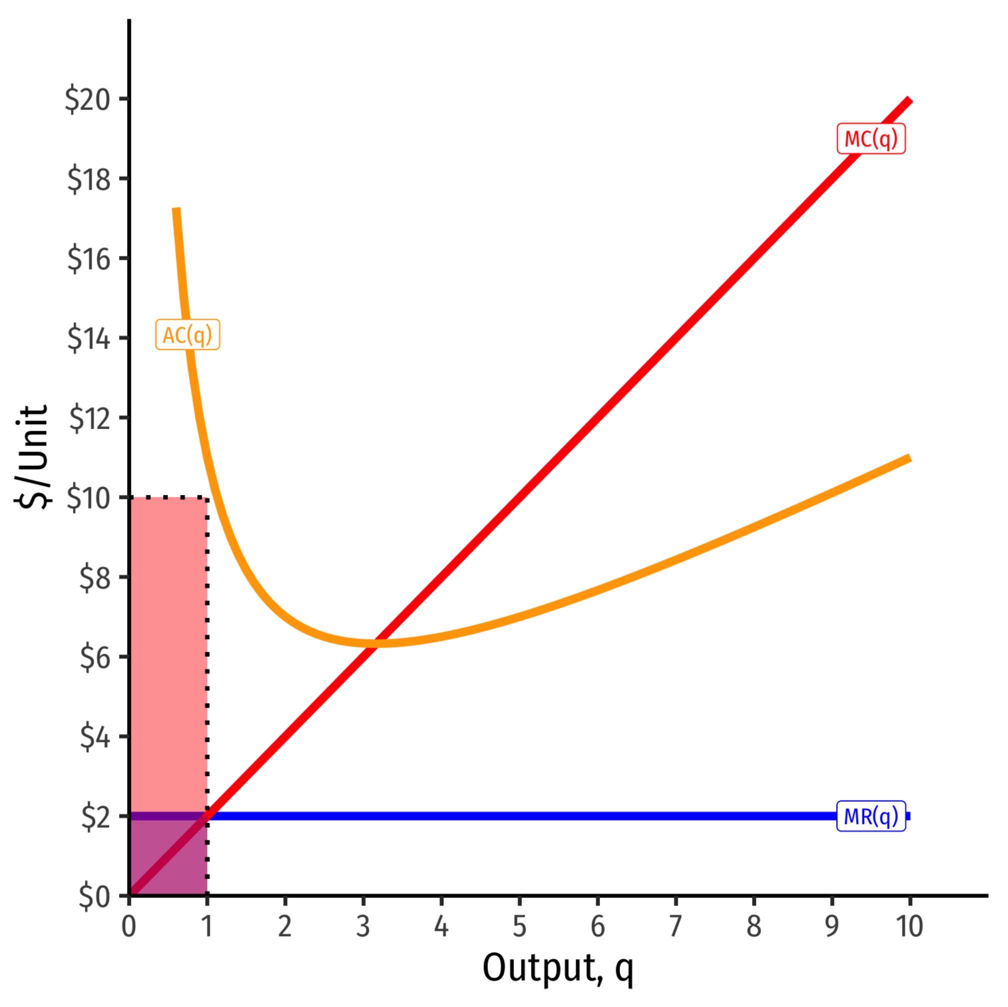
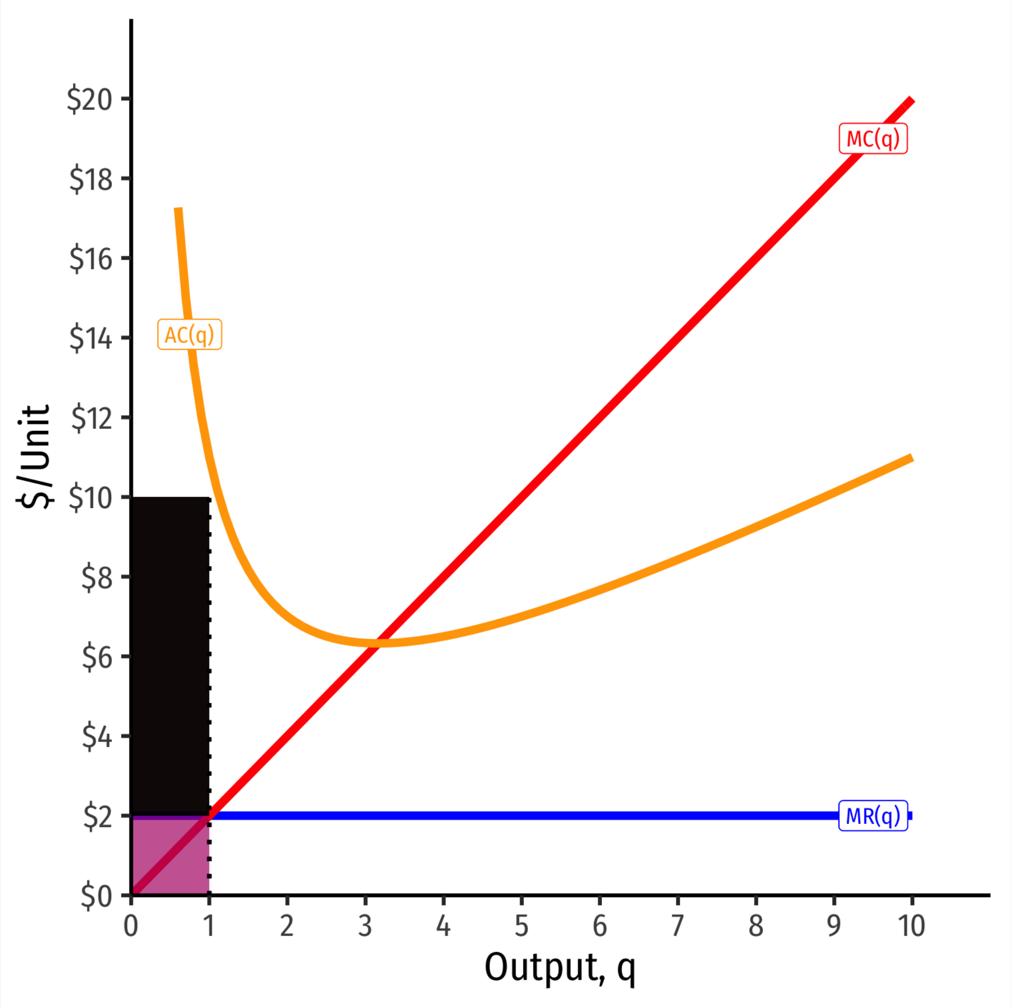
  - AC(1) = $10/unit
- At q* = 1 (totals):
  - R(1) = $2
  - C(1) = $10



Calculating Average Profit as $AR(q) - AC(q)$

- At market price of p* = $2
- At q* = 1 (per unit):
  - AR(1) = $2/unit
  - AC(1) = $10/unit
  - $A\pi(1)$ = -$8/unit
- At q* = 1 (totals):
  - R(1) = $2
  - C(1) = $10
  - $\pi(1)$ = -$8



Short-Run Shut-Down Decisions

Short-Run Shut-Down Decisions

- What if a firm's profits at q^* are **negative** (i.e. it earns **losses**)?

- Should it produce at all?

Short-Run Shut-Down Decisions

- Suppose firm chooses to produce **nothing** $(q = 0)$:
- If it has **fixed costs** $(f > 0)$, its profits are:

$$\pi(q) = pq - C(q)$$

Short-Run Shut-Down Decisions

- Suppose firm chooses to produce **nothing** ($q = 0$):
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$$\pi(q) = pq - C(q)$$
$$\pi(q) = pq - f - VC(q)$$

Short-Run Shut-Down Decisions

- Suppose firm chooses to produce **nothing** ($q = 0$):

- If it has **fixed costs** ($f > 0$), its profits are:

$$\pi(q) = pq - C(q)$$
$$\pi(q) = pq - f - VC(q)$$
$$\pi(0) = -f$$

Short-Run Shut-Down Decisions

- A firm should choose to produce nothing $(q = 0)$ only when:

$$\pi \text{ from producing} < \pi \text{ from not producing}$$

Short-Run Shut-Down Decisions

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$$\pi(q) < -f$$

Short-Run Shut-Down Decisions

- A firm should choose to produce nothing $(q = 0)$ only when:

$$\pi \text{ from producing} < \pi \text{ from not producing}$$
$$\pi(q) < -f$$
$$pq - VC(q) - f < -f$$

Short-Run Shut-Down Decisions

- A firm should choose to produce nothing $(q = 0)$ only when:

$$\begin{aligned} \pi \text{ from producing} &< \pi \text{ from not producing} \\ \pi(q) &< -f \\ pq - VC(q) - f &< -f \\ pq - VC(q) &< 0 \end{aligned}$$

Short-Run Shut-Down Decisions

- A firm should choose to produce nothing $(q = 0)$ only when:

$$
\begin{aligned}
\pi \text{ from producing} &< \pi \text{ from not producing}\\
\pi(q) &< -f\\
pq - VC(q) - f &< -f\\
pq - VC(q) &< 0\\
pq &< VC(q)
\end{aligned}
$$

Short-Run Shut-Down Decisions

- A firm should choose to produce nothing ($q = 0$) only when:

$$\begin{aligned} \pi \text{ from producing} &< \pi \text{ from not producing} \\ \pi(q) &< -f \\ pq - VC(q) - f &< -f \\ pq - VC(q) &< 0 \\ pq &< VC(q) \\ p &< AVC(q) \end{aligned}$$

Short-Run Shut-Down Decisions

- **Shut down price**: firm will shut down production *in the short run* when $p < AVC(q)$

The Firm's Short Run Supply Decision

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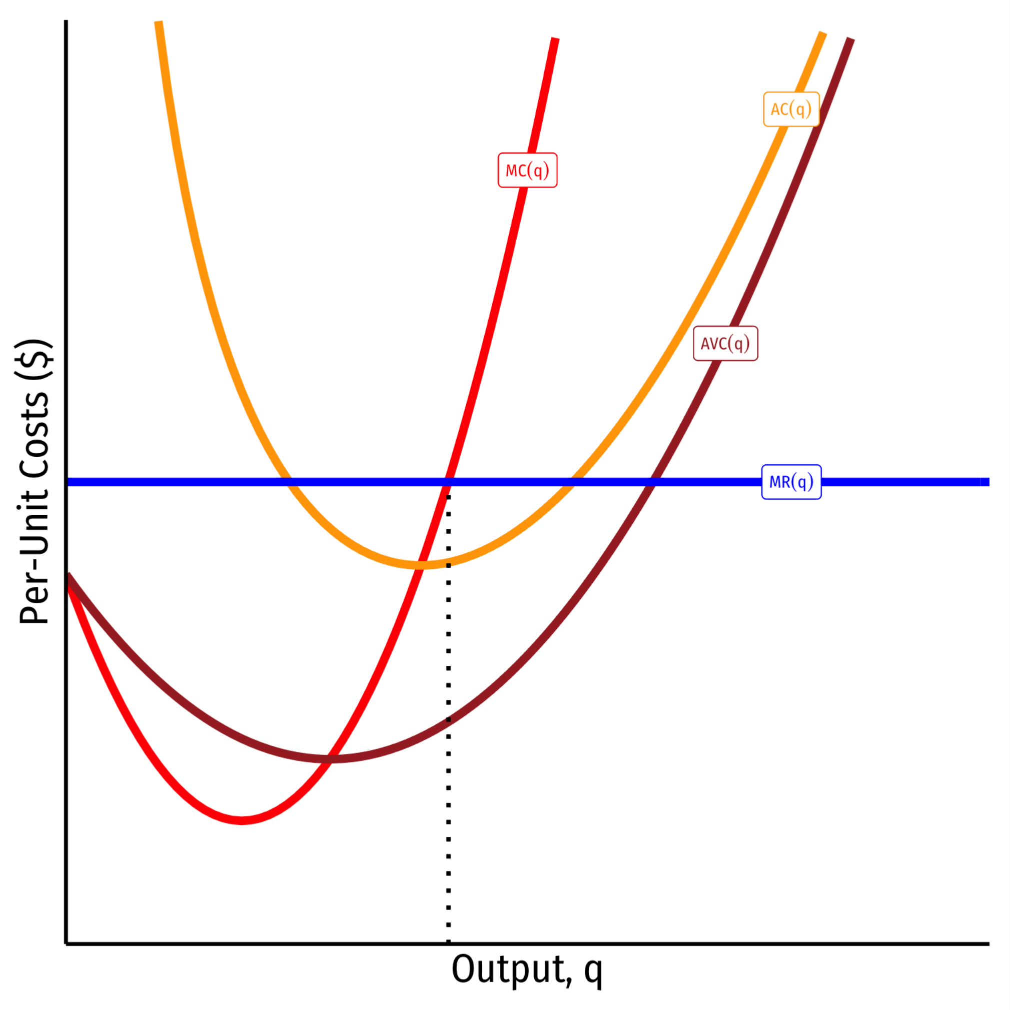
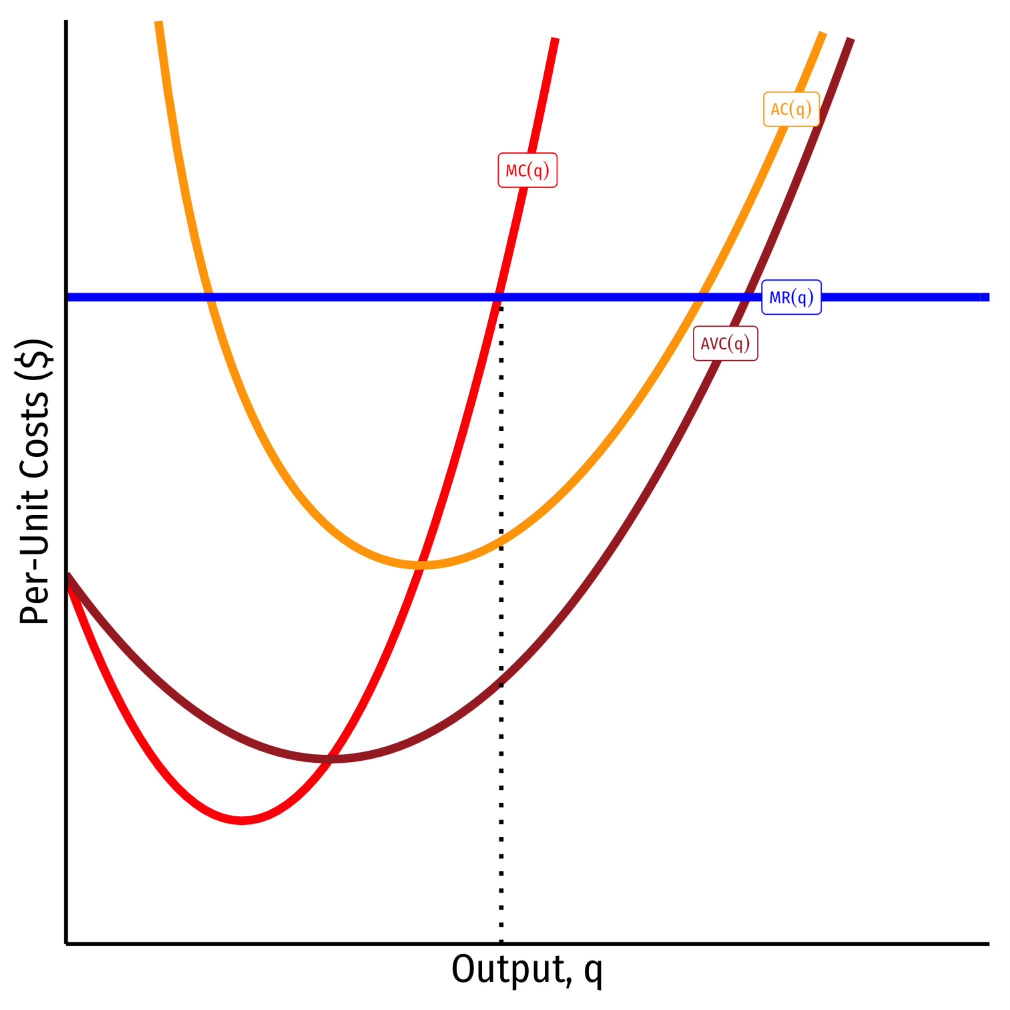
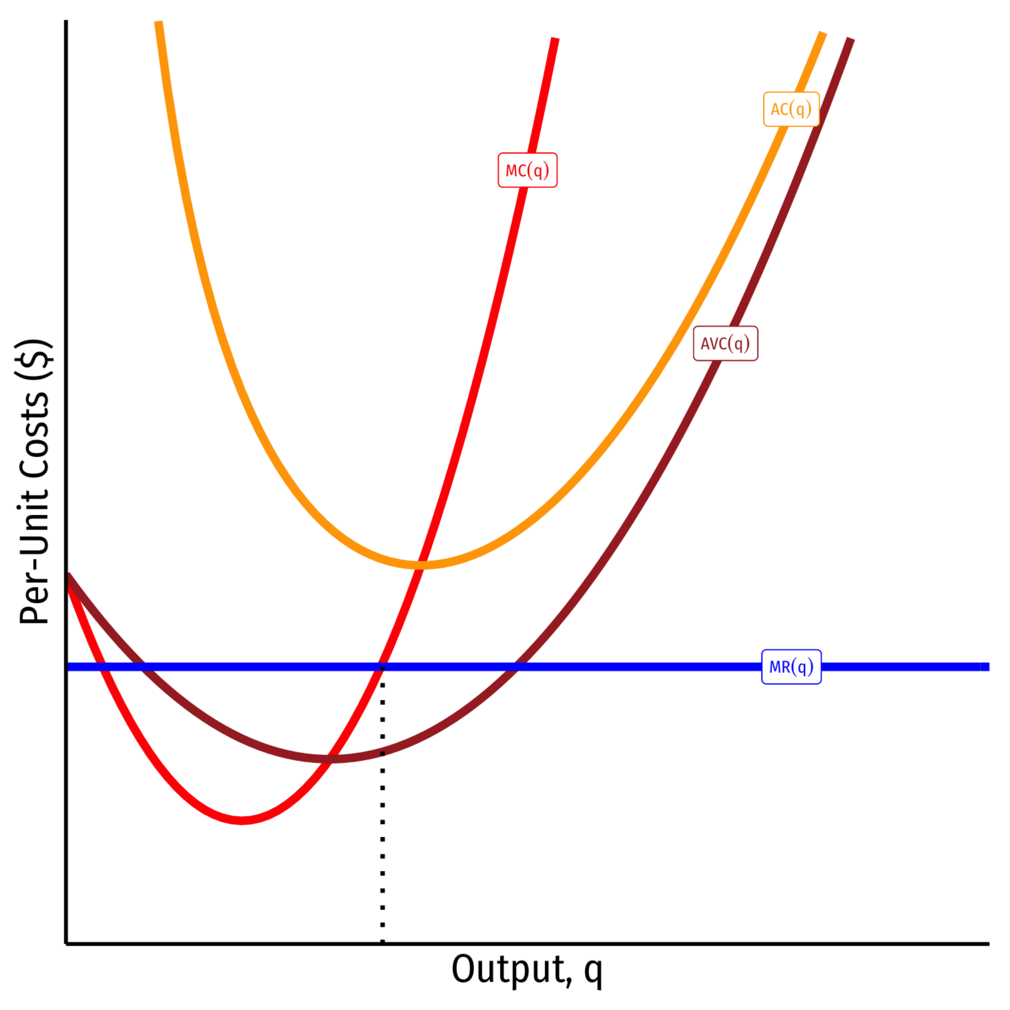


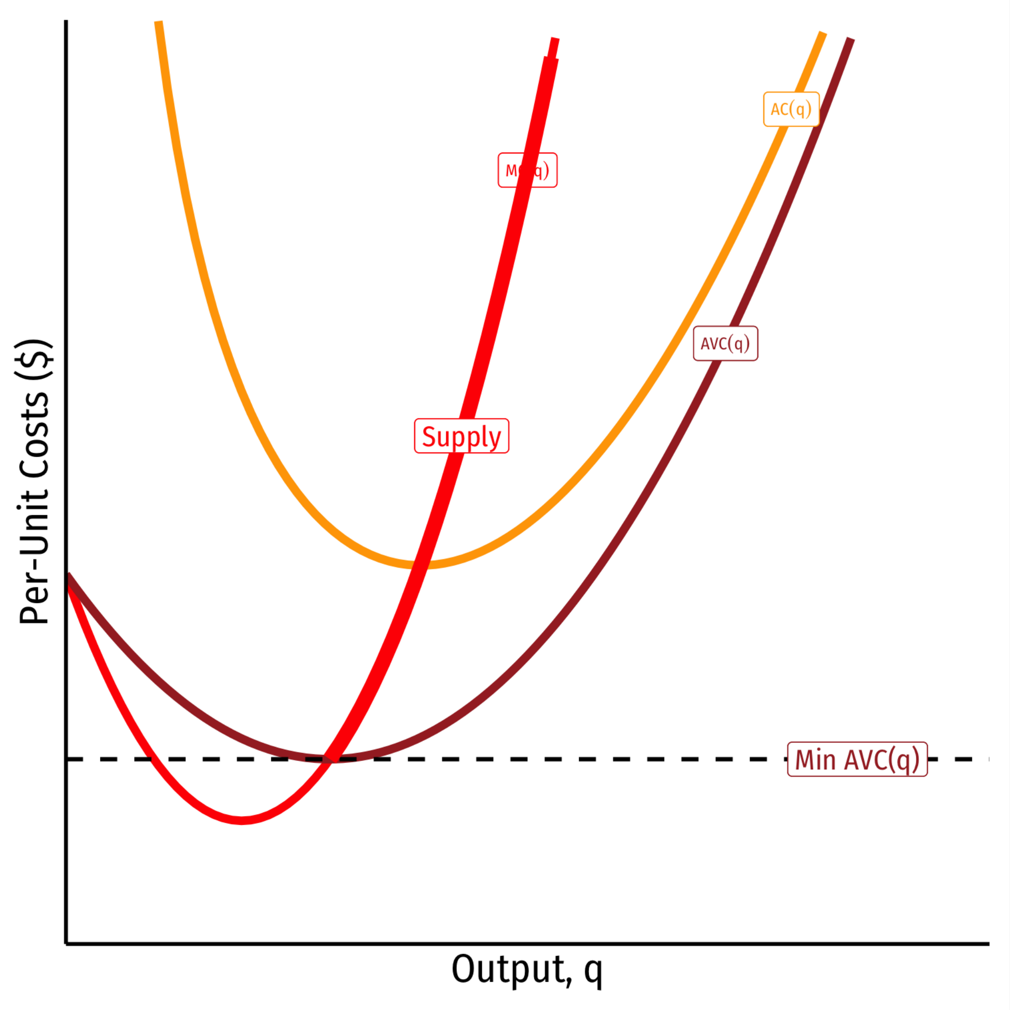
The Firm's Short Run Supply Decision



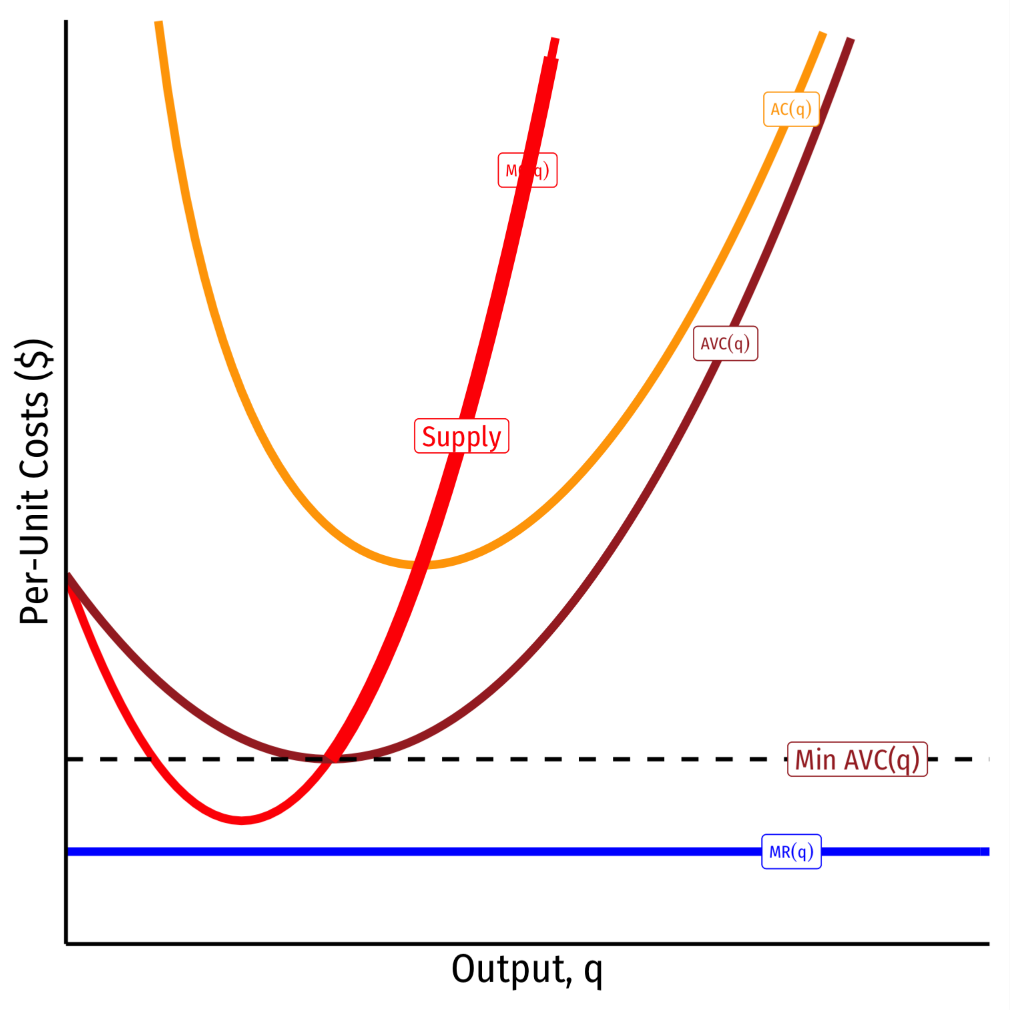
The Firm's Short Run Supply Decision



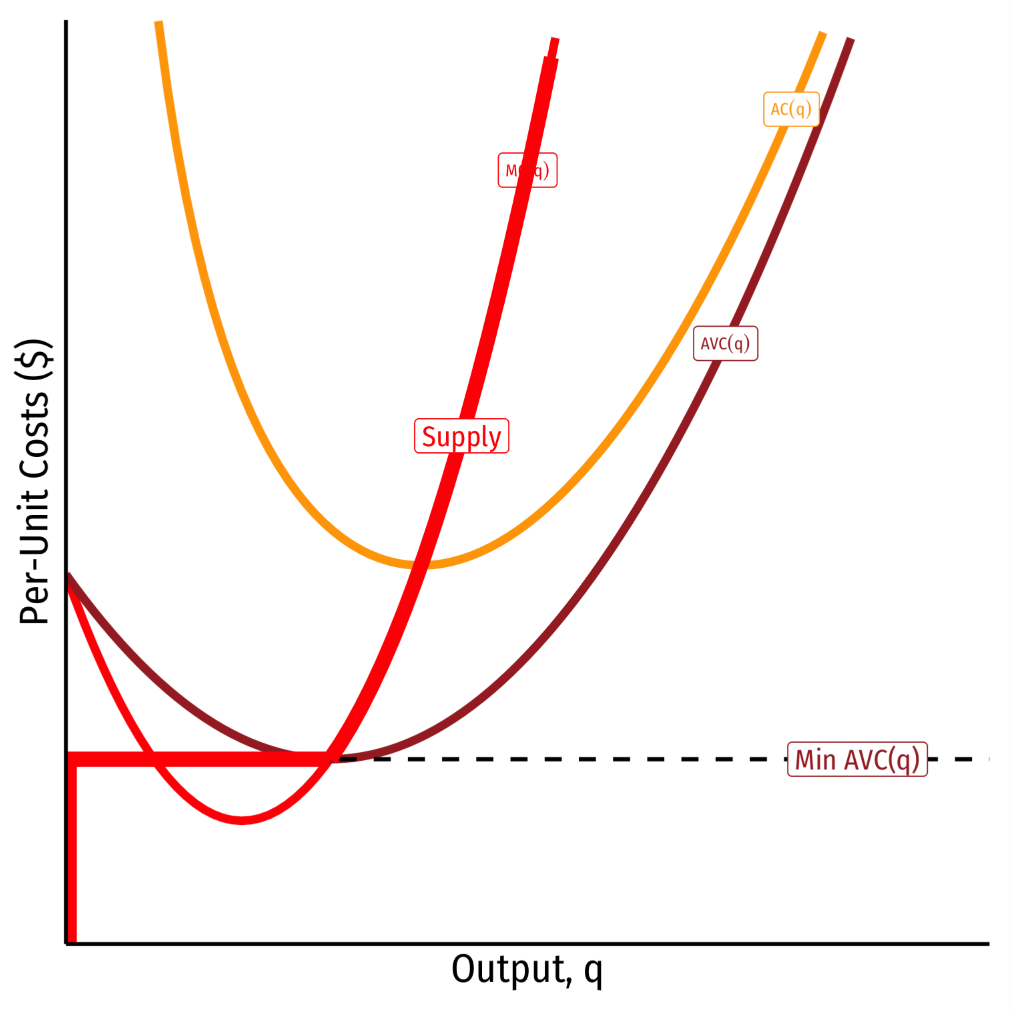
The Firm's Short Run Supply Decision



The Firm's Short Run Supply Decision



The Firm's Short Run Supply Decision



Firm's short run (inverse) supply:

$$\begin{cases} p = MC(q) & \text{if } p \geq AVC \\ q = 0 & \text{If } p < AVC \end{cases}$$

The Firm's Short Run Supply Decision

Firm's short run (inverse) supply:

$$\begin{cases} p = MC(q) & \text{if } p \geq AVC \\ q = 0 & \text{If } p < AVC \end{cases}$$

Summary:

1. Choose q^* such that $MR(q) = MC(q)$

2. Profit $\pi = q[p - AC(q)]$

3. Shut down if $p < AVC(q)$

Firm's short run (inverse) supply:

$$\begin{cases} p = MC(q) & \text{if } p \geq AVC \\ q = 0 & \text{If } p < AVC \end{cases}$$

Choosing the Profit-Maximizing Output q^*: Example

Example: Bob's barbershop gives haircuts in a very competitive market, where barbers cannot differentiate their haircuts. The current market price of a haircut is $15. Bob's daily short run costs are given by:

$$
\begin{aligned}
C(q) &= 0.5q^2 \\
MC(q) &= q
\end{aligned}
$$

1. How many haircuts per day would maximize Bob's profits?

2. How much profit will Bob earn per day?

3. Find Bob's shut down price.